WWII

SPITFIRE KEPT LUFTWAFFE AT BAY

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Hitler wanted a 1,000-tonne tank

Gigantic weapon swallowed up Nazi arms budget

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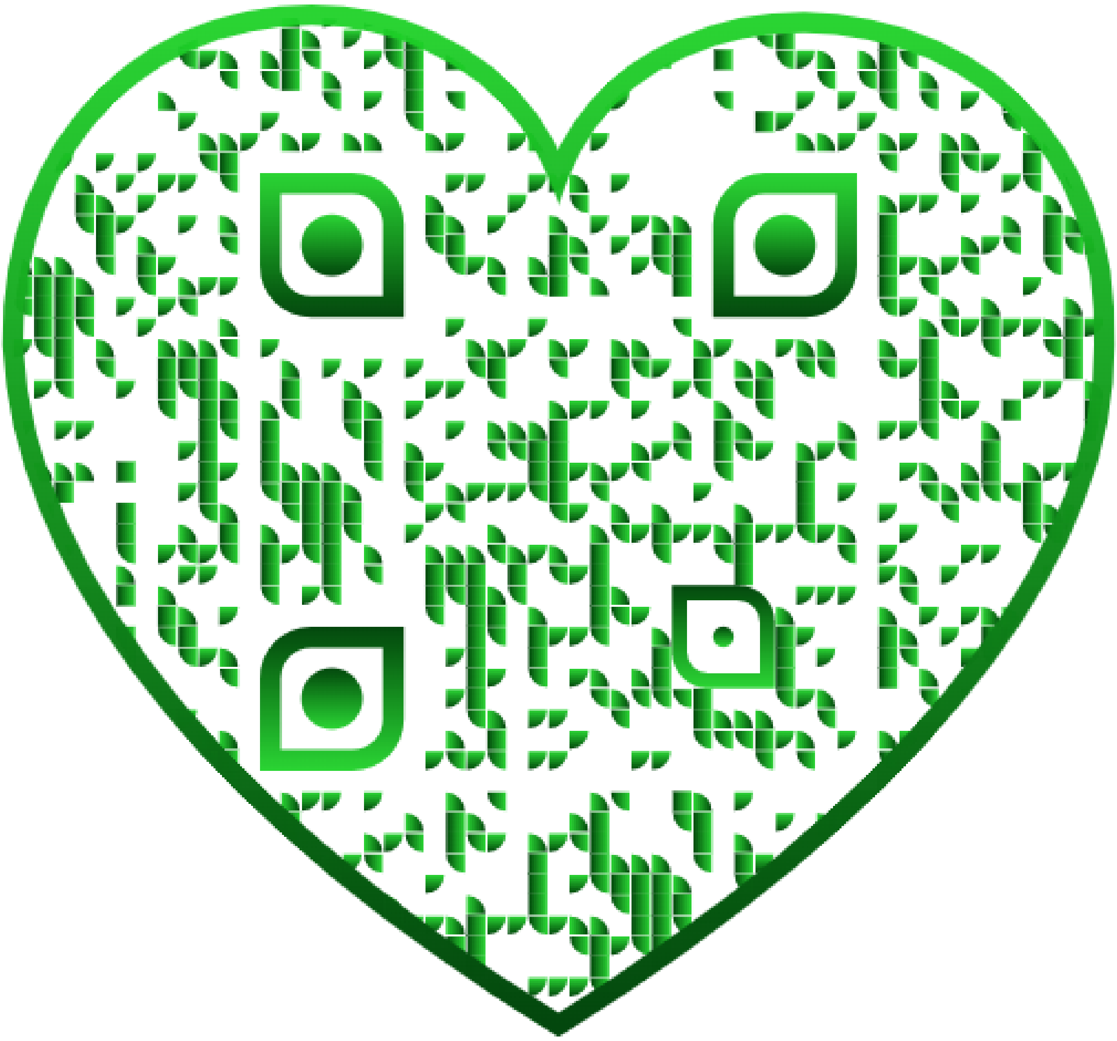
V-2 ROCKET RAVAGED LONDON

German terror intensified British fighting spirit

INVISIBLE PLANE WAS GERMANY'S LAST HOPE ★ BOMBERS ASSEMBLED FROM KITS

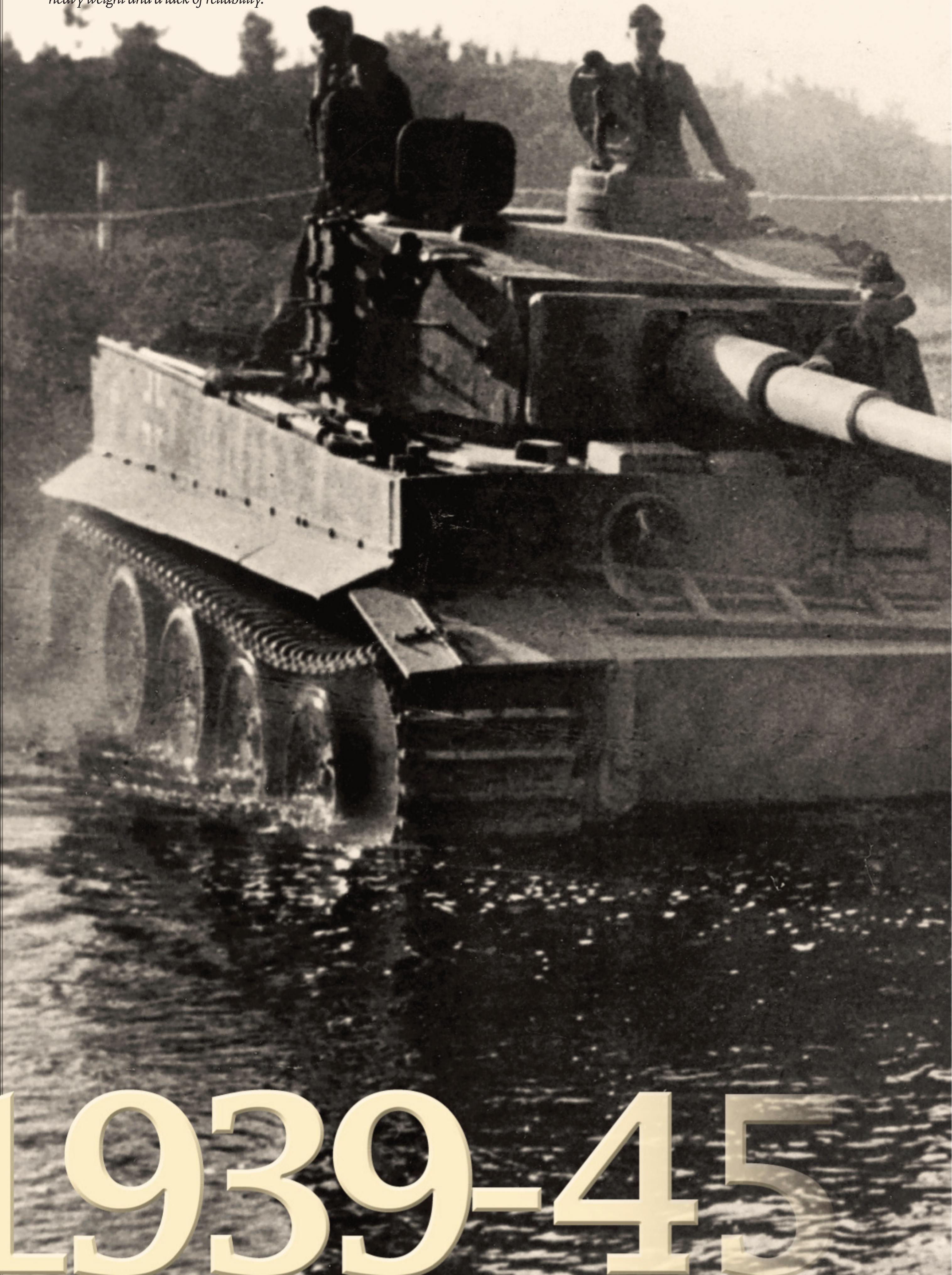


Agile plane secures victory

Luftwaffe pilots fear one weapon more than any other: British Spitfires. Powerful Rolls Royce engines and an ingenious design make the plane fast and manoeuvrable. In 1940, Spitfires and their fearless pilots resist Hitler's attempts to bomb Britain to submission.

The fighter's success forces Germany's leaders to develop even more powerful weapons. London is targeted by V-1 and V-2 bombs, forerunners of the Saturn V moon rocket. Meanwhile, on the Eastern Front the supergun Schwerer Gustav fires shells at targets 47 kilometres away. It's the heaviest gun in history at over 1,300 tonnes.

Nevertheless, the juggernauts cannot prevent the Nazis' defeat. With new weapons like the Mosquito bomber, designed to be built from a kit, the Allies slowly crush the Third Reich. In 1945, the atomic bomb also forces Japan to raise the white flag. *Incredible Weapons* explores the war's wildest weapons – including crazy projects like an aircraft carrier built from ice that came close to becoming a reality. Happy reading!



The Germans' Tiger I tank was bigger than anything else on the battlefield. But it suffered from its heavy weight and a lack of reliability.

1939-45

1939

6 **Treacherous mine confuses British**
The Germans are first to use a deadly magnetic mine.

1940

12 **Spitfire battles Messerschmitt to victory**
A new and fast fighter must defend Britain from the Luftwaffe.

1941

22 **German U-boats force Britain to its knees**
Hitler's most-feared weapon must sink thousands of cargo ships.

32 **Fantasy weapons leave the drawing board**
Engineers think big in the battle to develop the best weapons.

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Italian frogmen cripple British battleships in the Mediterranean.

1942

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32-metre-long steel monster can fire up to 47 kilometres away.

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German tank is the most powerful, but heavy and unreliable.

1944

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A weakened Luftwaffe gives Allied pilots free rein over Germany.

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German V-2 rockets terrorise the British.

1945

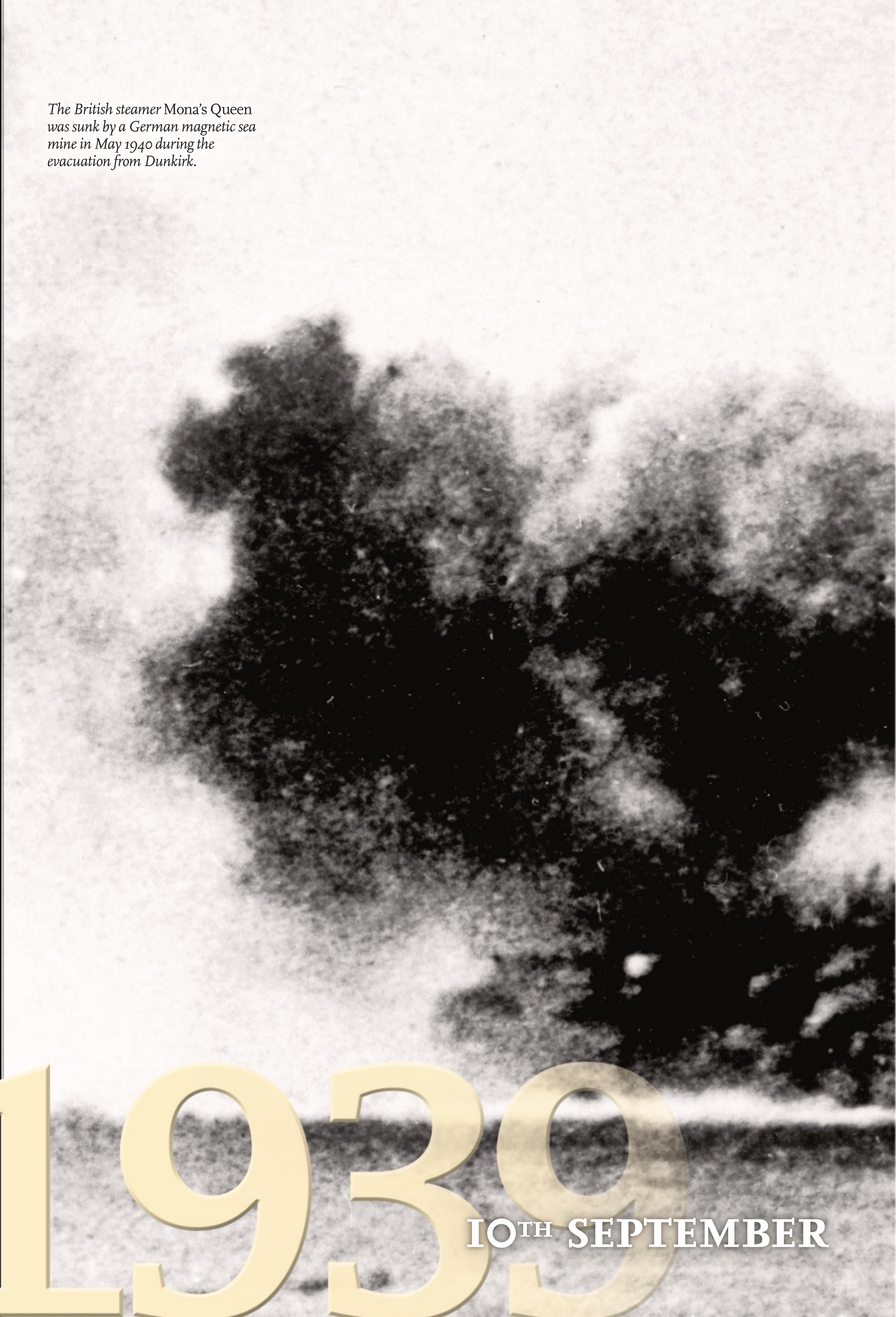
92 **Giant of the sea is sunk**
The world's largest battleship embarks on a suicide mission.

102 **Invisible plane is Hitler's last hope**
Two Germans brothers design planes to cheat the enemy's radar.

110 **Doomsday device is developed**
The Americans test a bomb that will end the war.

1939

10th SEPTEMBER

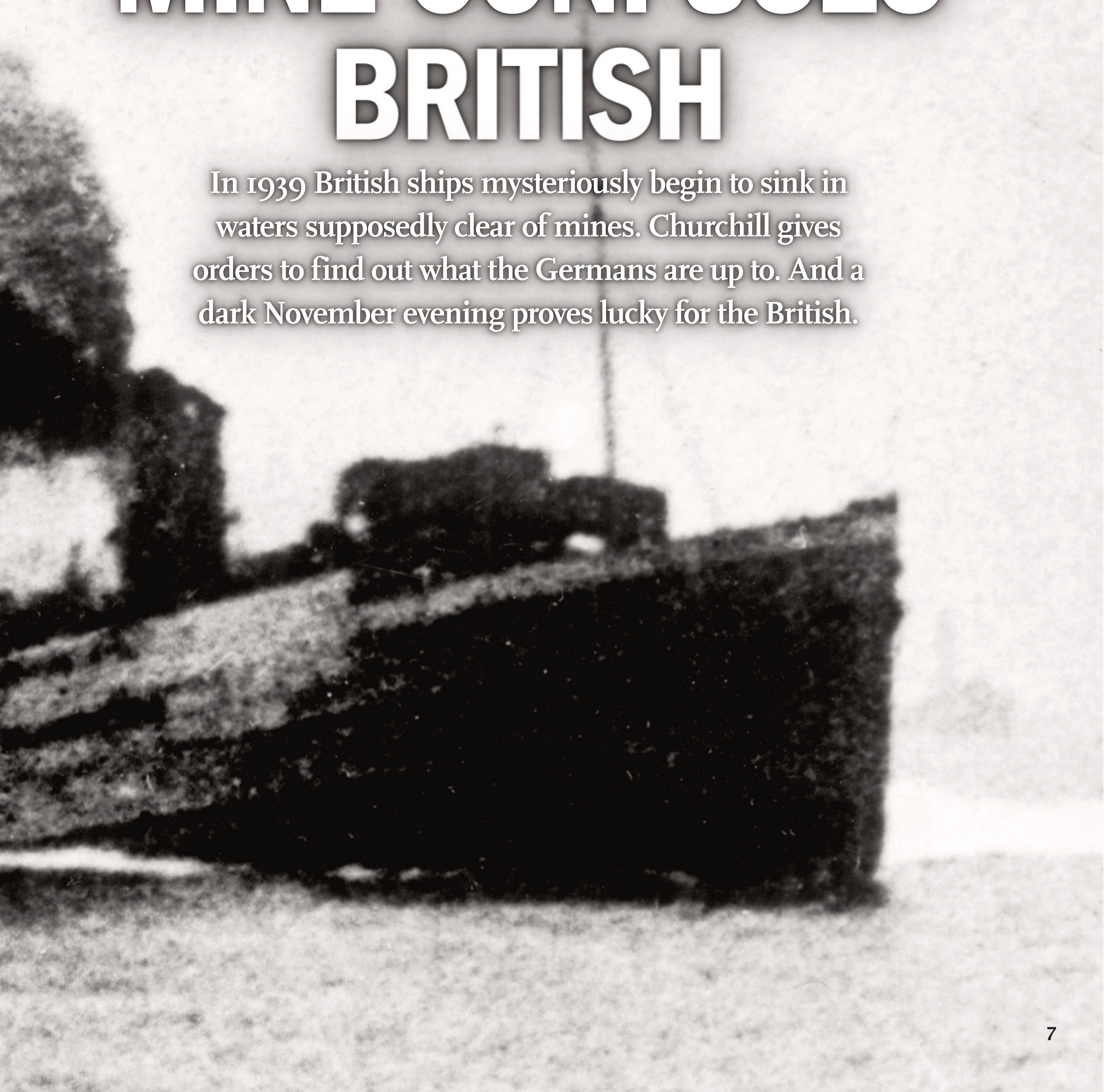


The British steamer Mona's Queen *was sunk by a German magnetic sea mine in May 1940 during the evacuation from Dunkirk.*

GERMAN SECRET WEAPON

TREACHEROUS MINE CONFUSES BRITISH

In 1939 British ships mysteriously begin to sink in waters supposedly clear of mines. Churchill gives orders to find out what the Germans are up to. And a dark November evening proves lucky for the British.



Great Britain, 1939

THE STAGE IS SET

The war has just begun, and the British are working to improve an old weapon – a mine that works by means of magnetism. But the Germans have had the same idea, and the Nazis are ahead of their enemy. At the outbreak of war they have assembled an arsenal of magnetic mines, which are used immediately.

GREAT BRITAIN

The ink on the war declaration to the German government was barely dry before the German fleet began to lay mines. Efforts were made during the first months to protect the homeland and block the waters off the ports on Britain's East Coast using mines deployed by surface vessels and submarines. But something new was also tried: magnetic mines dropped from aircraft.

In September, October and November 1939, the Germans deployed 500 of these newly developed mines. And it wasn't long before the mines snared their first victim. The British steamer *Magdepur* was struck and sank off the British coast on 10th September – only seven days after the outbreak of war. Six days later, the *City of Paris* came too close to a German mine, but made it to port.

As the weeks passed, there were more explosions, and the new mines gradually inflicted more losses than those from submarines. Among the British fleet, everyone was wondering what caused the blasts in waters that had supposedly been cleared of mines, and the intrigue deepened among politicians as well as in the admiralty. When the intelligence service received reports from captured German seamen that Germany had been releasing magnetic mines, the British put two and two together. Hitler had a new secret weapon, and the admiralty surmised that the weapon was a new type of mine.

The challenge now was to find out how the mines worked and – above all – how to render them harmless.

HMS Vernon was sunk by the German Navy, Joseph Goebbels announced to the amusement of the British. HMS Vernon was not a ship, but a land-based mining unit.

GERMANS DEVELOPED SENSITIVE SYSTEM

Magnetic mines were familiar to the British fleet. During WWI, the British had invented and put into commission 500 magnetic mines off the Belgian coast. However, the electromagnetic triggering system didn't work very well, so in 1918, the British put the project on hold.

It wasn't until the mid-1930s, when the situation began to deteriorate, and Nazi countries started behaving increasingly aggressively, that the

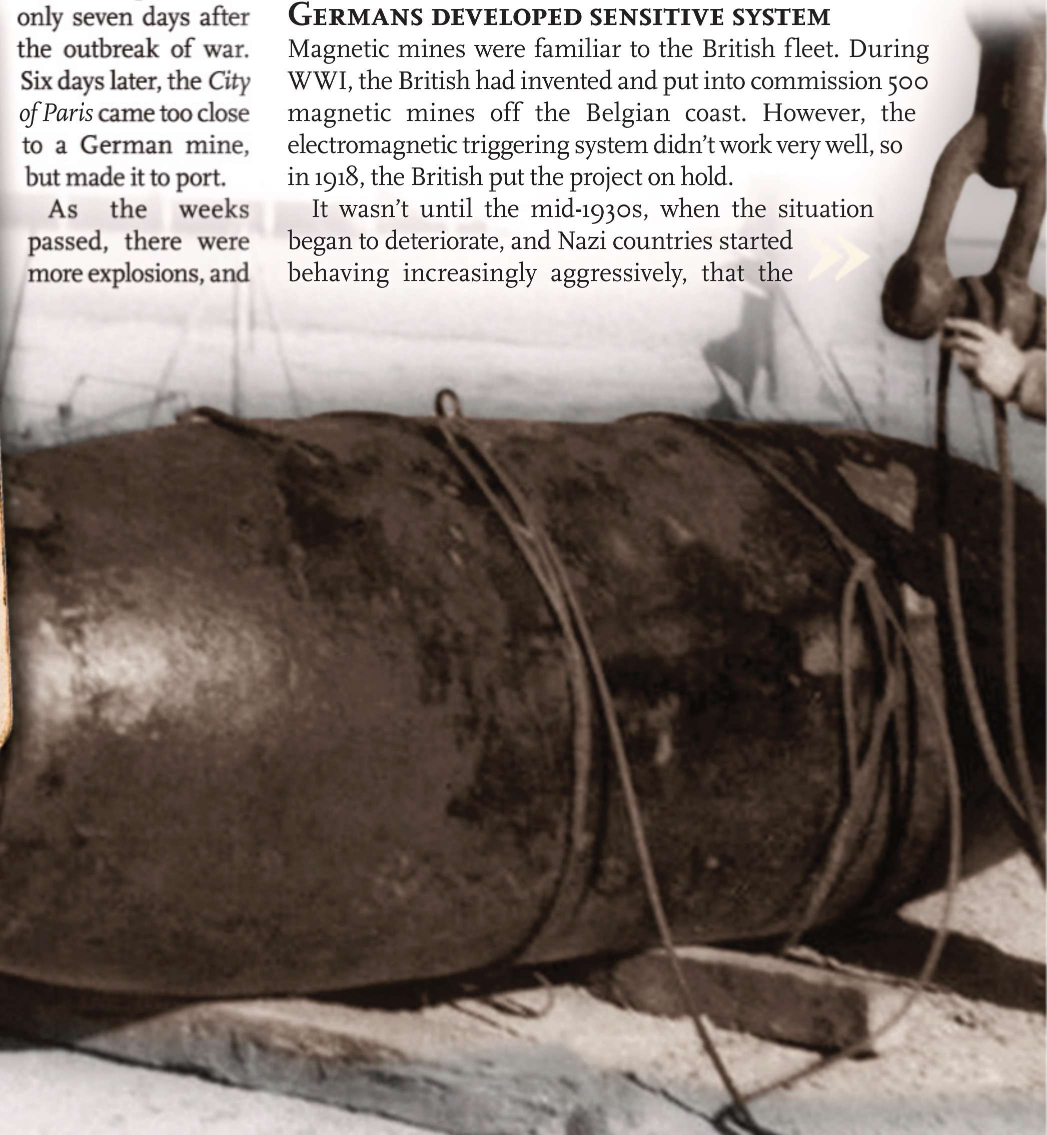
Magnetic mine

Length	2.1 metres
Diameter	66.6 centimetres
Weight	540 kg
Warhead	300 kg

GIANT BOMB LAY ON THE SEABED

The German magnetic mine was not magnetic in itself, but exploited the fact that metal ships produced a magnetic field. The field from a passing ship triggered a magnetic needle in the mine, which lay on the seabed, to connect an electrical circuit that detonated it.

A copy of the mine, which the British rendered harmless, is today exhibited on the museum ship *HMS Belfast* in London.

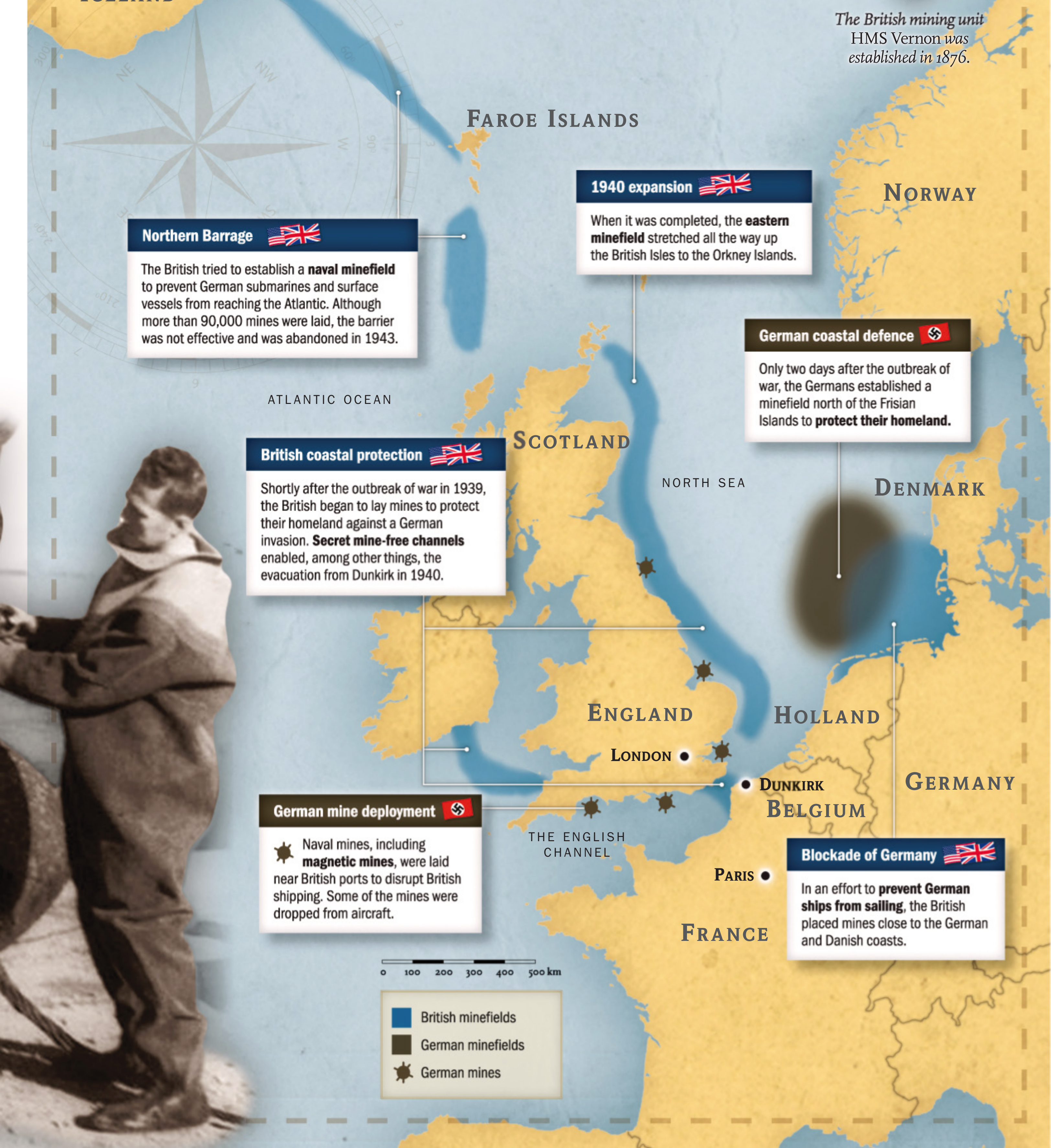


After being disarmed, magnetic mines could be recovered and examined by British experts.

Minefields supposedly protected against enemy invasion

Both Britain and Germany established mine fields to guard against invasion and stop enemy ships. Most of the fields consisted of traditional mines, but the Germans had a trump card up their sleeve that could be laid close to British ports.

The British mining unit HMS Vernon *was established in 1876.*


ICELAND
FAROE ISLANDS
NORWAY
ATLANTIC OCEAN
SCOTLAND
NORTH SEA
DENMARK
ENGLAND
HOLLAND
LONDON
DUNKIRK
GERMANY
BELGIUM
THE ENGLISH CHANNEL
PARIS
FRANCE
0 100 200 300 400 500 km

Northern Barrage 🇺🇸🇬🇧

The British tried to establish a **naval minefield** to prevent German submarines and surface vessels from reaching the Atlantic. Although more than 90,000 mines were laid, the barrier was not effective and was abandoned in 1943.

1940 expansion 🇺🇸🇬🇧

When it was completed, the **eastern minefield** stretched all the way up the British Isles to the Orkney Islands.

German coastal defence

Only two days after the outbreak of war, the Germans established a minefield north of the Frisian Islands to **protect their homeland.**

British coastal protection 🇺🇸🇬🇧

Shortly after the outbreak of war in 1939, the British began to lay mines to protect their homeland against a German invasion. **Secret mine-free channels** enabled, among other things, the evacuation from Dunkirk in 1940.

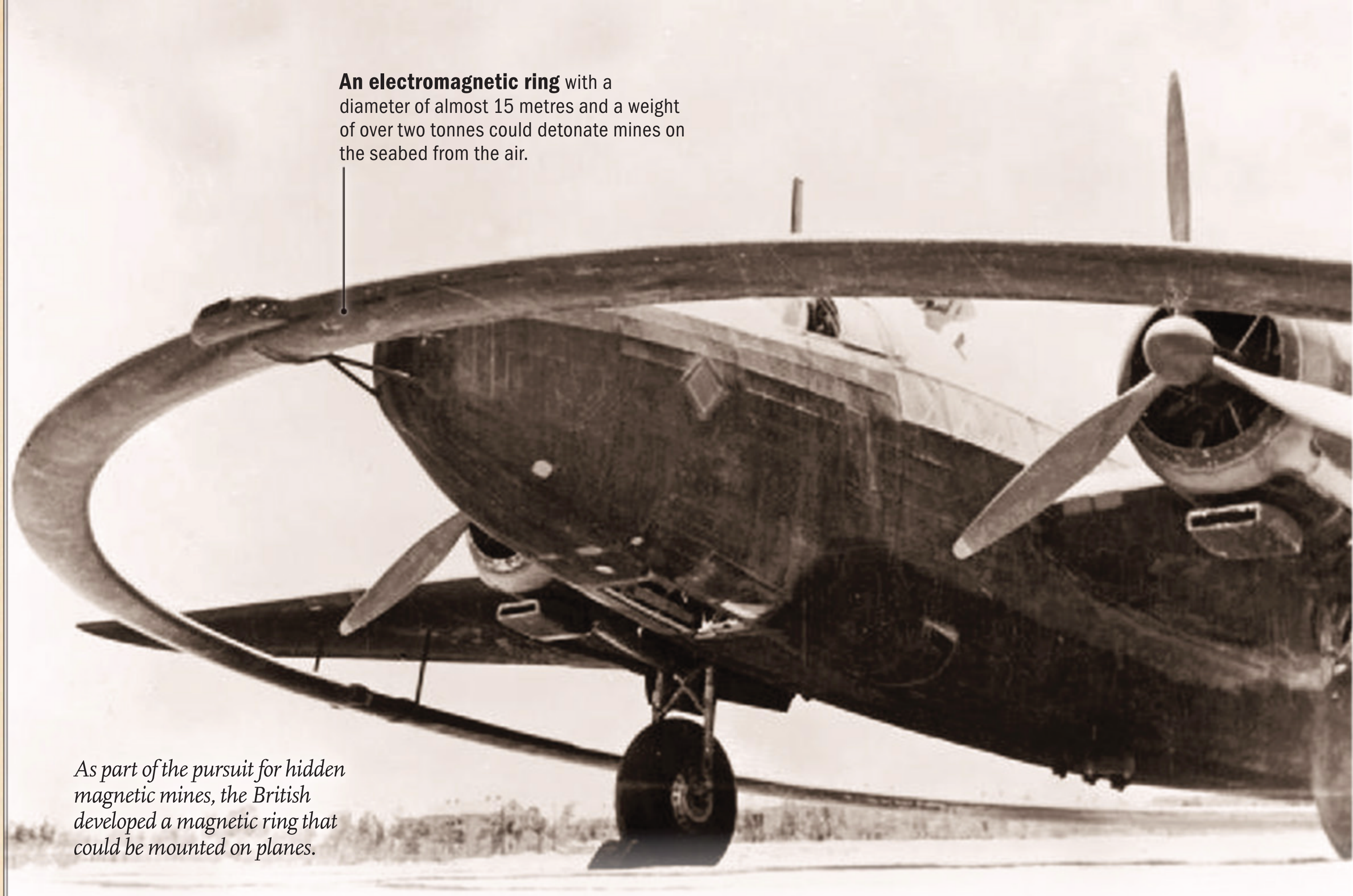
German mine deployment

✸ Naval mines, including **magnetic mines**, were laid near British ports to disrupt British shipping. Some of the mines were dropped from aircraft.

Blockade of Germany 🇺🇸🇬🇧

In an effort to **prevent German ships from sailing**, the British placed mines close to the German and Danish coasts.

- 🟦 British minefields
- ⬛ German minefields
- ✸ German mines



An electromagnetic ring with a diameter of almost 15 metres and a weight of over two tonnes could detonate mines on the seabed from the air.

As part of the pursuit for hidden magnetic mines, the British developed a magnetic ring that could be mounted on planes.

British resumed development. At the start of the war in September 1939 the naval mining unit *HMS Vernon* in Portsmouth had advanced far in developing a British model. In fact, in March 1938 Winston Churchill, then First Lord of the Admiralty, proposed in a letter to Defence Minister Thomas Inskip that in the event of war against Germany, the British should place magnetic mines in the Kiel Canal. But the Germans beat them to the punch. By the end of the 1920s, a small development group had constructed a reliable magnetic ignition, and from 1935 development had reached the point where the mine went into mass production. By the outbreak of war, the Germans had around 1,500 magnetic mines ready.

3,000
British ships were demagnetised in a process called "wrapping", which used live cables to counter German magnetic mines.

Officers were woken

One of the mines gave the British an unexpected breakthrough. In the evening of 22nd November, a patrol saw a German plane dropping something in the water at the mouth of the Thames. The Coast Guard believed that it was a man in parachute and waded out to investigate. But the tide forced the men back to land, and instead they reported the incident to London. Luckily Churchill and Admiral of the Fleet Dudley Pound had previously decided to keep two of *HMS Vernon's* experts on standby.

Regular mines that floated on the sea's surface did not cause as much damage as magnetic mines.

Lieutenant Commander John GD Ouvry and RC Lewis were woken at the London hotel where they were staying and ordered to recover the item at all costs. At 01.30 the officers were on their way. The night was dark and it was raining, but with the help of a signal lamp, it was possible to locate the object – a cylindrical aluminium container, about two metres long and about 60 centimetres in diameter. At the tip it had a tubular horn that stretched to all sides, and the back housed room for a parachute. Eventually, Ouvry and Lewis identified the cylinder as a magnetic mine – the British had managed to capture an intact copy of the German's secret weapon.

Disarming was dangerous

At noon the next day, demagnetising tools from the mining section in Portsmouth arrived in addition to tools that were custom-made for the task. During the night Ouvry and his assistant emptied their pockets of any metal objects and waded to the mine. And while the rest of the salvage team remained at a respectful distance, the two men began to disarm the mine. As the work progressed, Ouvry reported to Lewis, who stayed a distance away. Ouvry's observations could be useful if the bomb went off and he died during the disarming. Fortunately, it did not happen. After some nervous minutes, Ouvry carefully detached the detonator, rendering the 500-kilogram mine harmless.

The mine was loaded on a truck and driven to Portsmouth for further investigation where – on Churchill's orders – staff worked day and night to reveal its secrets. The British investigations revealed a so-called magnetic sensor, which did not require actual physical contact to detonate.

The special thing about the German model in relation to what the British had worked on was that it was developed using a new and far more reliable principle. The British version was based on a magnetic coil – a system that tended to fail. When a ship passed the German mine, it emanated a magnetic signature causing a magnetically charged needle on the mine to drop, connect an electrical circuit and trigger the explosive charge.

Pressure waves hit below the waterline

At the same time, the magnetic mine was surprisingly simple. Until now, magnetic mines could only be installed by ship because the iron shell made them too heavy to be transported by air. But the German mine had a lightweight aluminium shell and could be dropped from almost everywhere.

British technicians also discovered that when the mine was laid, a number of devices ensured that it was working and that the water depth was correct. When all systems reported clear, the mine armed itself and was ready for blasting. If not – for example, if the mine was in low water – it was set to blow up immediately so as to not fall into the enemy's hands. Luckily for the British, this security measure had failed in the mine that was fished out of the Thames.

The magnetic mines were far more dangerous than ordinary mines floating on – or just below – the water's surface. Traditional mines typically caused damage to the front of the ship and around the waterline, which in many cases could be repaired. But devastating pressure waves from the magnet mines hit the waterline on load-bearing structures causing damage that was almost impossible to repair at sea.

Magnetic field was neutralised

At *HMS Vernon*, a research team led by CF Goodeve was challenged to find a way to defuse the German magnetic mines. And at the end of December, Goodeve was able to give Churchill a Christmas present: the research team had invented a technique called "degaussing", named after physicist and magnetic-field pioneer Carl Friedrich Gauss.

The method involved installing electromagnetic coils in the ship, which neutralised the ship's magnetic field. This was expensive, so a cheaper option was devised known as "wiping", whereby a large electric cable exposed ships to strong magnetic fields that demagnetised them, but this was only a temporary fix, and wiping had to be repeated regularly.

The research team also developed techniques for locating the mines: these minesweepers were largely constructed from wood and fitted with high-power cables that they dragged behind them. The cables created powerful magnetic fields that caused the underwater magnetic mines to explode.

The hunt extended to the air. Bombers were equipped with a metal ring that served as a giant electromagnet. The ring generated such a large magnetic field that many magnetic mines detonated when the plane passed at low altitude.

Germany was undaunted and continued to deploy magnetic mines. From the beginning of 1942, German submarines laid about 330 magnetic mines off the east coast of the US, sinking 11 ships. But, thanks to British countermeasures, the threat had been largely eliminated in Europe.

PERSPECTIVE

Thousands of mines were removed

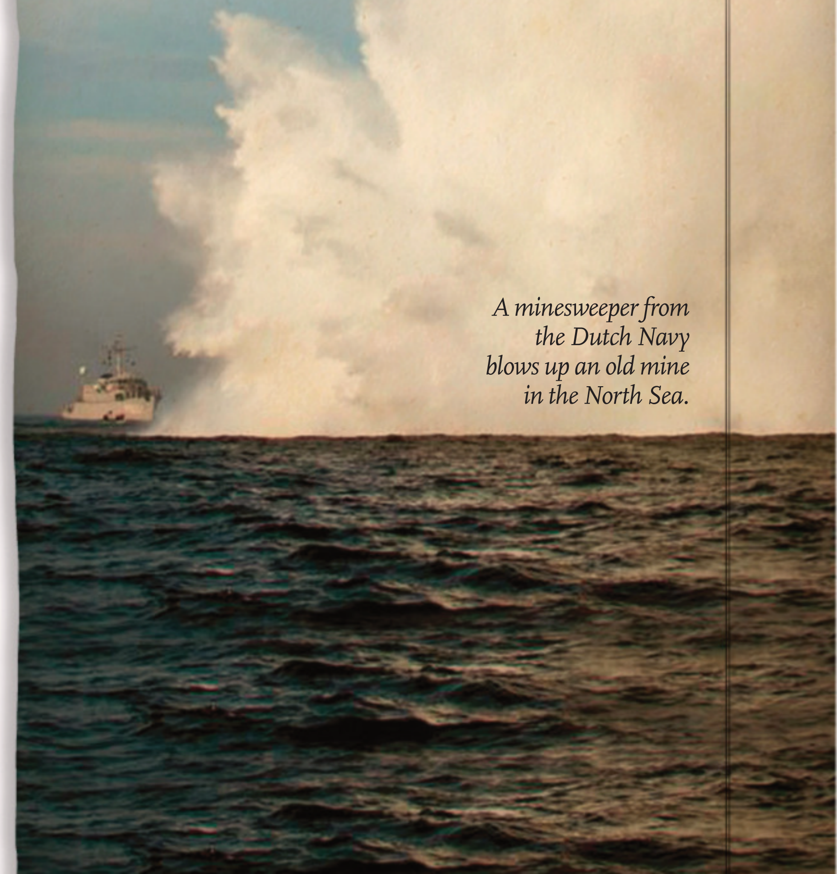
Sea mines were effective, but after the war a colossal job of removing the deadly mines followed – a job that is still ongoing.

A large number of the hundreds of thousands of sea mines laid during the war were never accounted for. Mine clearance after the war was therefore a giant task, which was carried out primarily by Britain's Royal Navy, which had the greatest expertise in mine clearance.

However, despite the efforts, the seas still hide mines. During the construction of Nord Stream, a natural gas pipeline from Russia to Germany that was completed in 2012, miners found around 80 unexploded mines in a 50-metre-wide corridor being cleared on the Baltic seabed.

Efforts are also taking place in the North Sea. After a tragic episode in 2005, when three Dutch fishermen died when their cutters hit a mine, Operation Beneficial Cooperation was launched. The project is an international collaboration, and so far more than 1,000 mines have been detonated.

700,000	mines were released during the war.
650	Allied ships were lost as a result of mines.
1,100	Axis ships sank.
1,100	old mines have been detonated in the North Sea since 2005 through an international project.



A minesweeper from the Dutch Navy blows up an old mine in the North Sea.

BRITISH FIGHTER PLANE

SPITFIRE BATTLES MESSERSCHMITT TO VICTORY

In the 1930s, Briton Reginald Mitchell is under intense pressure to develop a fighter plane that can stand up to Hitler's powerful air force. But as the Spitfire's development is delayed again and again, the threat of a German invasion of Britain grows...

1940

20TH AUGUST

Spitfires patrolled British airspace to prevent German bombers from attacking the country during World War II.

England, 1940

THE STAGE IS SET

BRITAIN
Southampton

In 1931 the Royal Air Force has only outdated biplanes and wants a new modern fighter to defend the country against the increasing threat from Germany's Luftwaffe. The question is whether British engineers can develop a new machine to surpass Hitler's awesome Messerschmitt fighters.

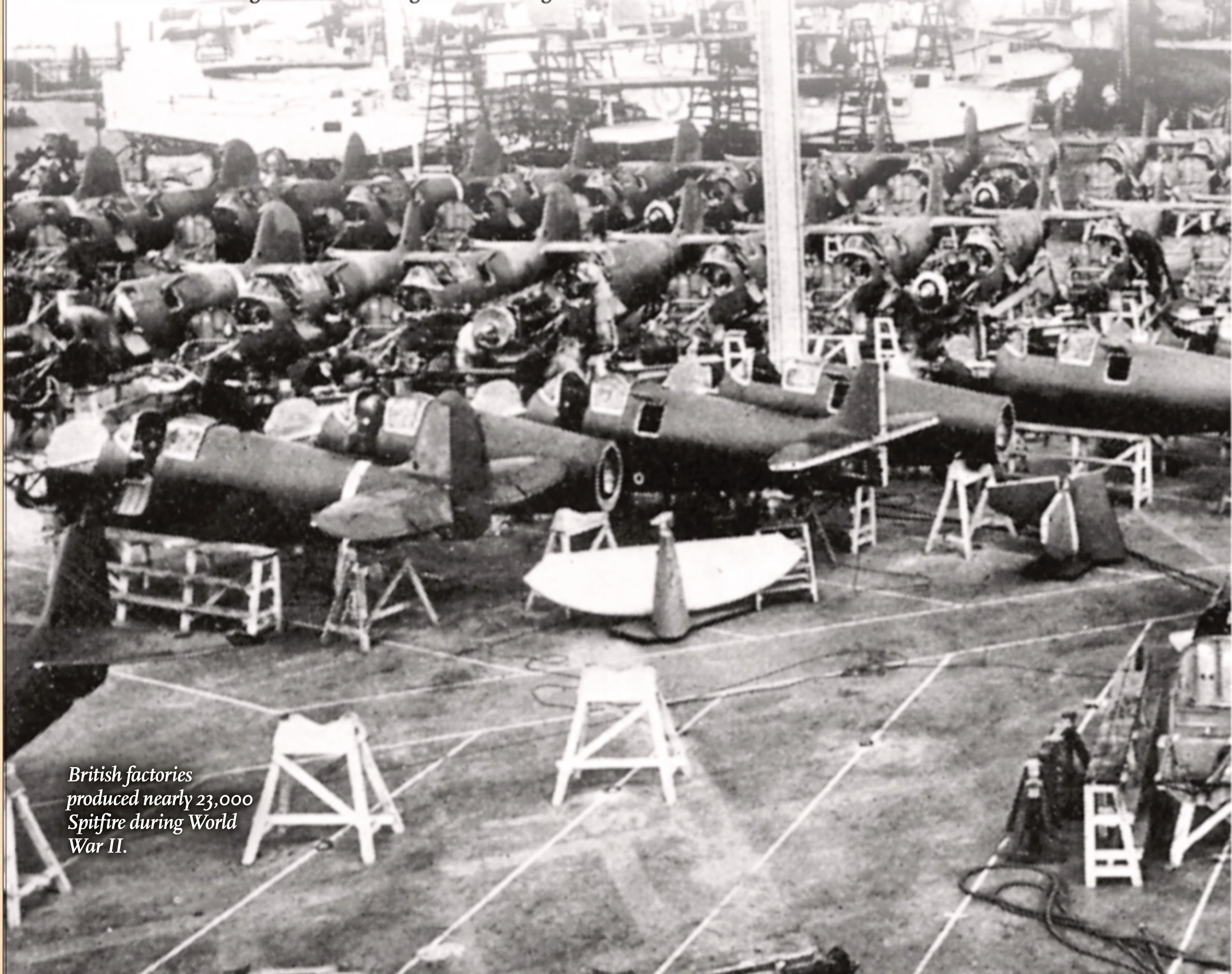
The Battle of Britain was raging in the airspace above Winston Churchill when the Prime Minster made his speech on 20th August, 1940: "Never in the field of human conflict was so much owed by so many to so few". Churchill directed his famous remark to the pilots of the Royal Air Force, but his praise could just as easily been aimed at the RAF's new weapon: the Spitfire.

The fighter plane with its characteristic slim profile and ellipse-shaped wings was one of the world's best fighters – both a killer and a young boy's dream. The Spitfire became crucial to the RAF's victory over the German Luftwaffe in the summer of 1940, but in fact, the plane came excruciatingly close to never making it off the drawing board. The fighter was so advanced that designer Reginald Joseph Mitchell's great and ambitious childhood dream was close to never being realised.

Plane designer started out building trains

Mitchell was born in 1895 and was eight years old when the Wright brothers made history's first engine-powered flight in December 1903. The feat made a great impression on Mitchell, who developed a lifelong obsession with aircraft.

Mitchell wanted to work in the plane industry as a young boy. However, when he left school at the age of 16 in 1911, flight was still in its infancy, and job opportunities were limited. Instead Mitchell focussed on a career as a locomotive builder,



British factories produced nearly 23,000 Spitfire during World War II.

but when he saw a job advert from aircraft manufacturer Supermarine in 1916, he applied immediately – and got it!

Mitchell overcame his natural trepidation to head to Supermarine's Southampton factory. All he dreamed of was developing aircraft, and his enthusiasm drove him on. Thanks to his ability to mix blue-sky thinking with a grounded mind, Mitchell rose from assistant to chief engineer in the space of just a few years and his first major achievement was to build a plane that took second place in a flight competition.

Thus, the stage was set: over the following years, Mitchell designed a large number of aircraft that could start and land on water. With these planes, Supermarine won the prestigious Schneider Trophy, which was given for a race between seaplanes and flying boats, in 1927, 1929 and again in 1931. The Schneider race had captured the world's imagination since 1913, and with three wins in a row, Mitchell assured that Britain had the trophy in perpetuity.

The British winning plane from 1931 was called S.6B. At that time the record speed was 300 km/h, but Mitchell's machine set a world record with a top speed of 655 km/h. He felt ready for the call that came when the Air Ministry started looking for a replacement for the outdated Bristol Bulldog biplane fighter in 1931.

The result of his efforts became Supermarine Type 224 – a further development of the seaplane S.6B. The plane had a clumsy base, open cockpit and one set of wings. Monoplanes, as such vessels are called, were not a completely new invention, but the few which had been designed in Britain were accompanied by a swarm of stiffeners and support wires from the body to the wings, creating air resistance that prevented the planes from getting enough speed. Mitchell, however, believed that he could construct a thin wing without external stiffeners if the traditional canvas cloth was replaced with a self-supporting shell of metal.

When Type 224 took flight in February 1934, however, the plane turned out to be a disaster – especially its climb speed, which was far below the wishes of the Air Ministry.

Following the test flight, the Ministry deemed the plane did not meet its demands. The Type 224 lost out to the Gloster Gladiator, an old-school biplane with a rapidly approaching expiration date.

MITCHELL BECAME ILL

It wasn't only in his professional life that Mitchell experienced adversity; in the summer of 1933 while working with the Type 224 he was hospitalised with »

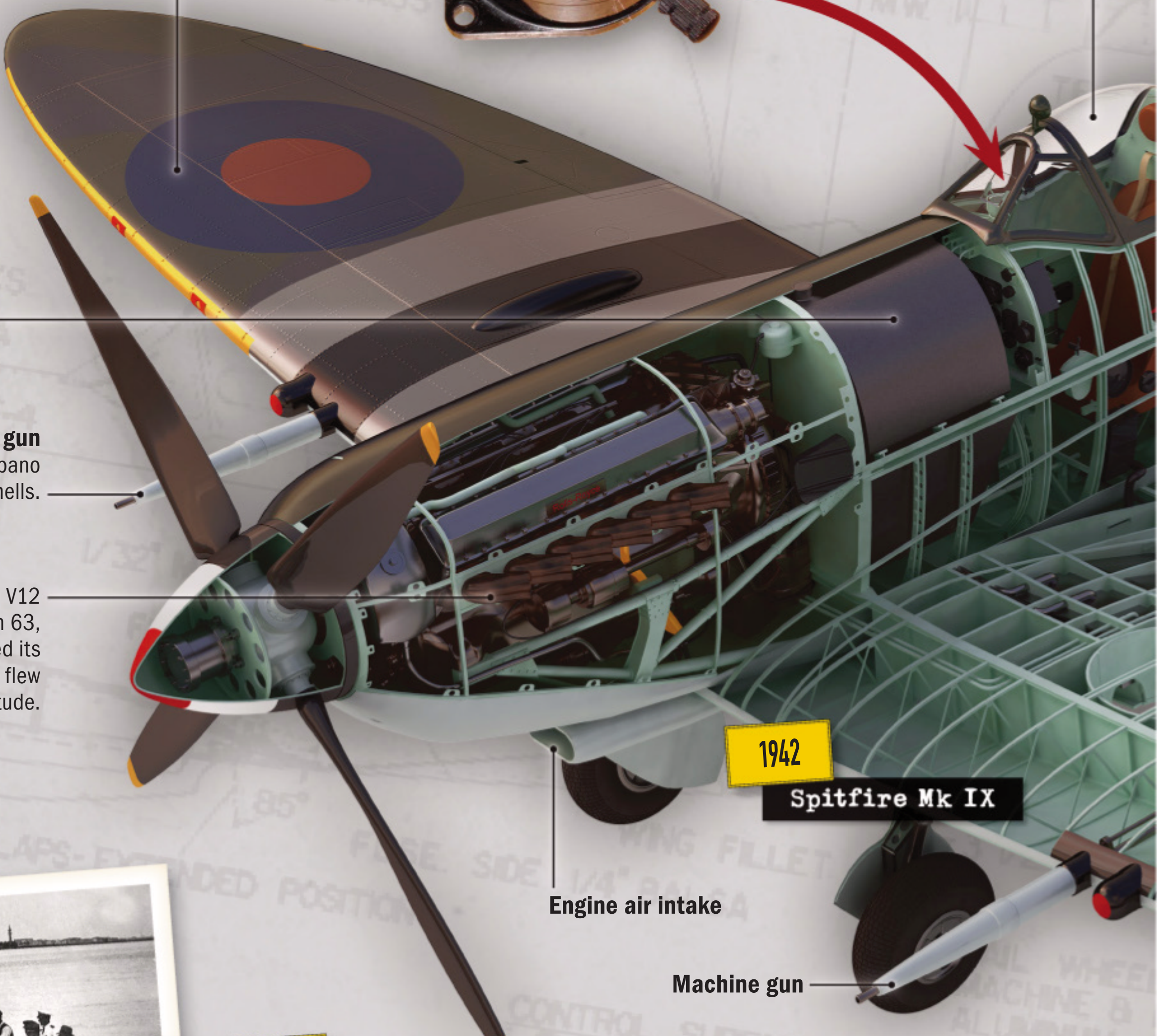
A RAF pilot's emergency equipment included a life jacket.

FIGHTER PLANE

Spitfire was like a ballerina in flight

Britain's new fighter plane – Spitfire – was produced in 24 different versions with different engines and wings, but common to all of them was their superb manoeuvrability.

The pilots could keep an eye on the time using a special Bakelite clock sitting in the cockpit.



The closed cockpit made the body more aerodynamic compared to previous aircraft with an open cockpit. Conditions were also less cramped than in the German Messerschmitt Bf 109.

RAF logo

The forward tanks contained about 320 litres of fuel. When full, the Spitfire could fly up to 1,900 kilometres.

The machine gun was branded Hispano and fired 20-mm shells.

The engine – a V12 Rolls-Royce Merlin 63, 1,712 hp – performed its best when the plane flew at high altitude.

1942

Spitfire Mk IX

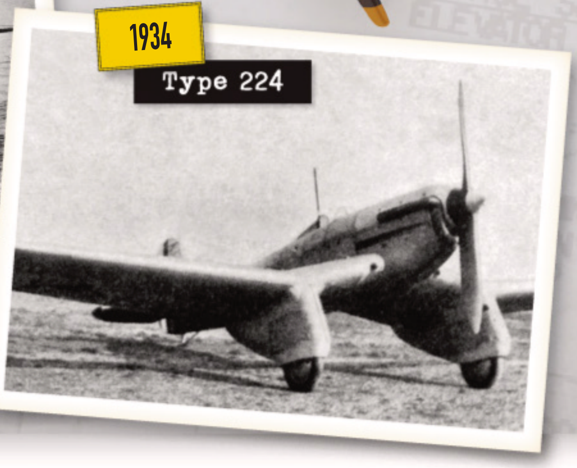
Engine air intake

Machine gun

Browning machine guns were standard armaments in Spitfire aircraft. Flaps covered them so the weapon did not freeze before it was fired.

1931

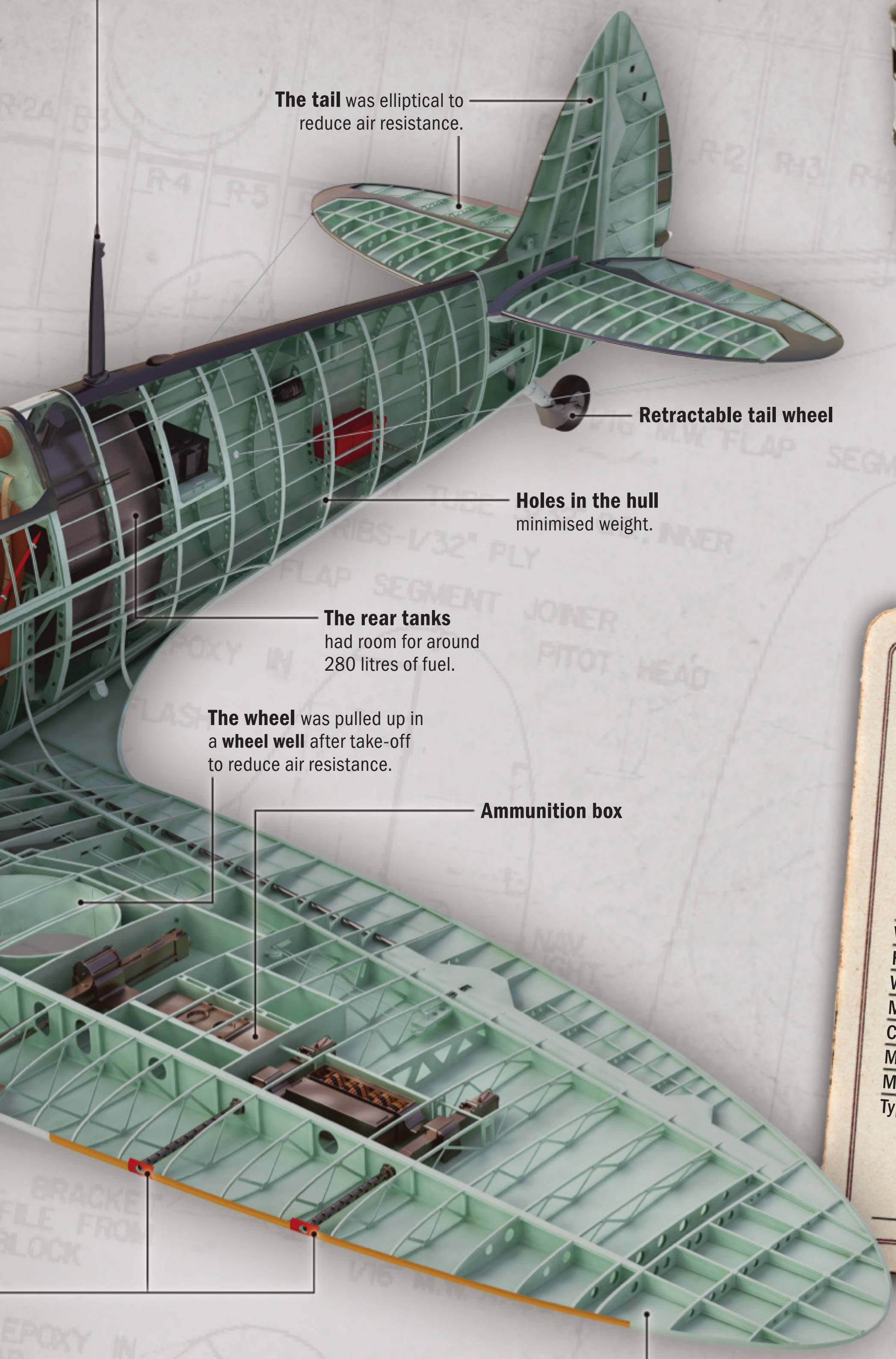
S.6B



1934

Type 224

Reginald Mitchell's watercraft S.6B was completed in 1931 and set records of 655 km/h. In 1934, the Briton designed the fighter plane Type 224.



The radio antenna was aerodynamically shaped.

The tail was elliptical to reduce air resistance.

Retractable tail wheel

Holes in the hull minimised weight.

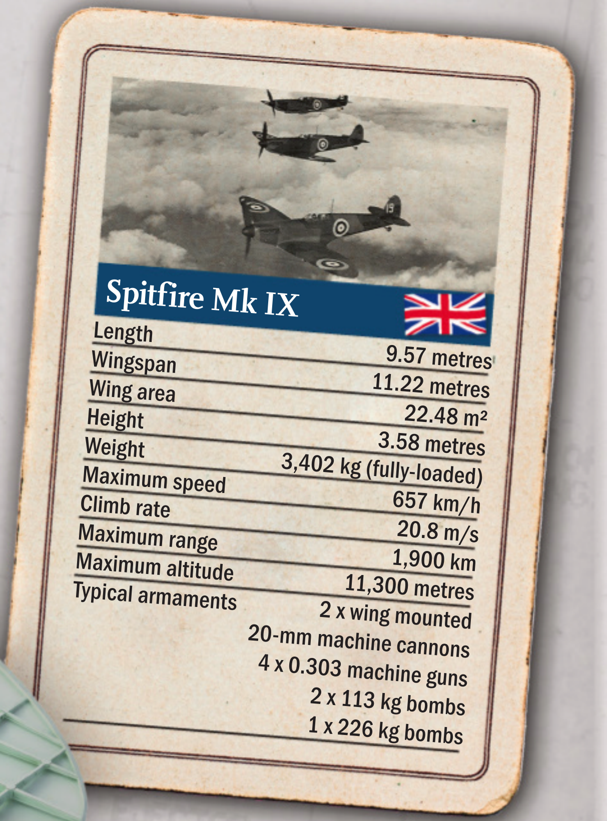
The rear tanks had room for around 280 litres of fuel.

The wheel was pulled up in a **wheel well** after take-off to reduce air resistance.

Ammunition box

The elliptical wing was one of Mitchell's most ingenious ideas because it reduced air resistance and also provided space for landing gear and weapons.

Cockpit light openings could be adjusted to give the right amount of light.



Spitfire Mk IX

Length	9.57 metres
Wingspan	11.22 metres
Wing area	22.48 m²
Height	3.58 metres
Weight	3,402 kg (fully-loaded)
Maximum speed	657 km/h
Climb rate	20.8 m/s
Maximum range	1,900 km
Maximum altitude	11,300 metres
Typical armaments	2 x wing mounted 20-mm machine cannons 4 x 0.303 machine guns 2 x 113 kg bombs 1 x 226 kg bombs

Prime Minister Winston Churchill boosted worker morale during visits to Spitfire plants.

colon cancer. Even though the Briton returned to work at Supermarine in spring 1934, doctors warned him that the cancer could return at any time.

But Mitchell did not stop and continued his passion: to build a plane. After his return, the aircraft developer immediately decided to convert Type 224 into a winner. The body itself was aerodynamically sound, but the rest of the plane had to be changed: the clumsy landing gear was replaced with a retractable undercarriage that could be pulled up into the wing, the open cockpit replaced by an enclosed one, and the wing structure changed radically.

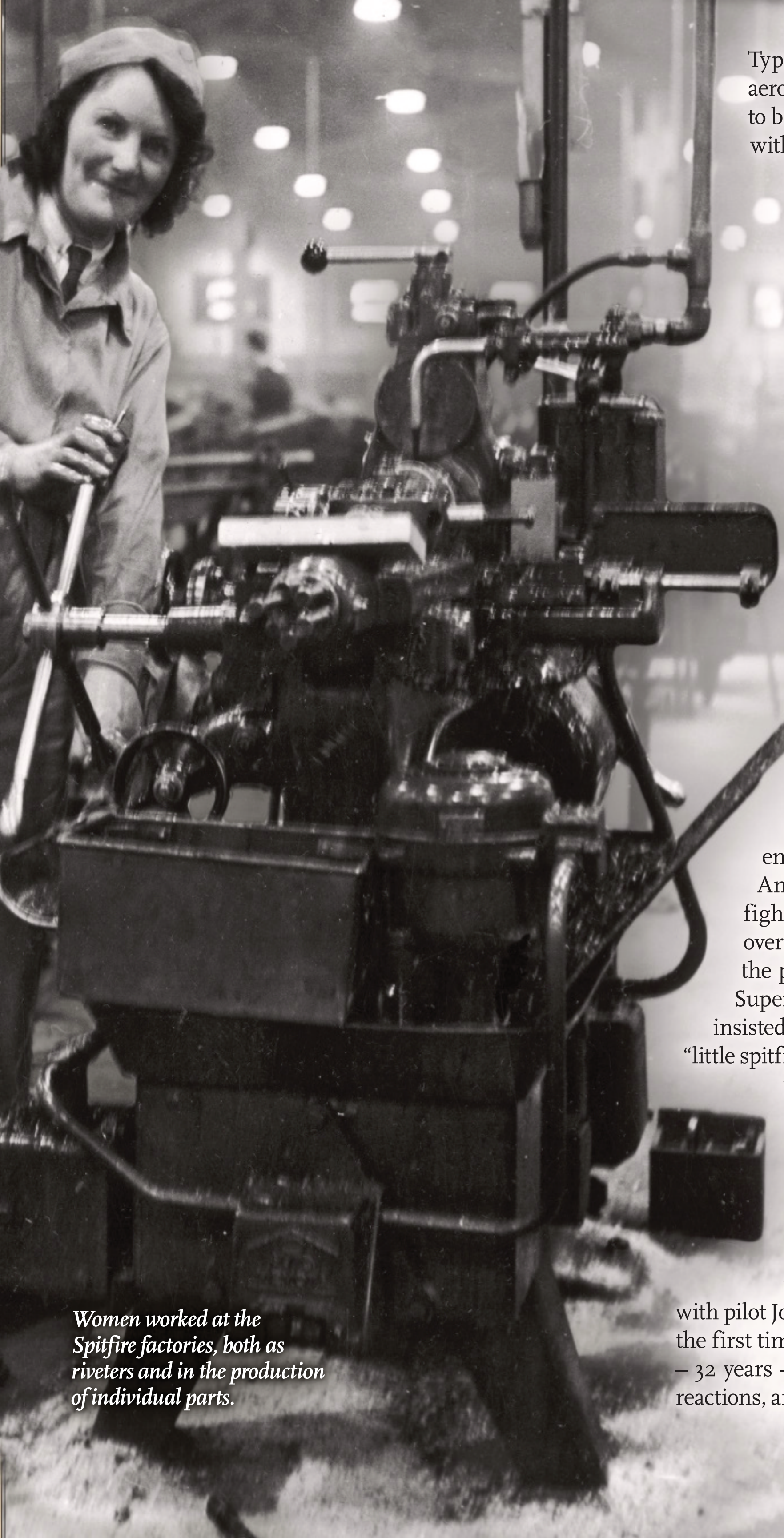
Mitchell's vision was that the plane should be armed with four machine guns under each of the wings – an unprecedented reinforcement at the time. To create the necessary space, the Briton created a thin, elliptical wing, which also added excellent aerodynamic properties to the aircraft.

The challenge was to find an engine that gave the plane enough power. A proper engine was required if the fighter was to measure up against the fighters that were under development in Germany and elsewhere. Mitchell had a good collaborative relationship with Rolls-Royce, and once again the factory delivered a powerful engine – a V12 with over 1,000 horsepower.

Among the names that were in play for the new fighter were "Shrew" or "Scarab" but both were overruled – however, Mitchell was indifferent to what the plane was called. Robert McLean, the director of Supermarine's parent company, Vickers-Armstrong, insisted that the aircraft should be called Spitfire, after his "little spitfire" of a daughter; it had also been assigned to the rejected Type 224.

When Mitchell learned that the director was fixated on the name Spitfire, he thought that it was "cursed to name the plane after a previous failure". He preferred to refer to his vessel as "The Plane" or "Type 300".

Mitchell was finally ready to let the Spitfire take flight for the first time in spring 1936, and with pilot Joseph Summers at the controls, the plane flew for the first time on 5th March. Despite his relatively young age – 32 years – Summers was a seasoned pilot with lightning reactions, and people said he could fly a kitchen table if it only



Women worked at the Spitfire factories, both as riveters and in the production of individual parts.

had a propeller. With Summers in the cockpit, the Spitfire behaved like a dream, and when he landed eight minutes later, he was surrounded by an avid crowd who turned up to hear what he thought. As he took off his helmet, Summers was firm in his assessment:

"Don't touch a single thing". In short, the pilot was excited and in agreement with the Air Ministry delegates who attended the test flights. It appeared Britain had something that surpassed anything the Germans had yet built.

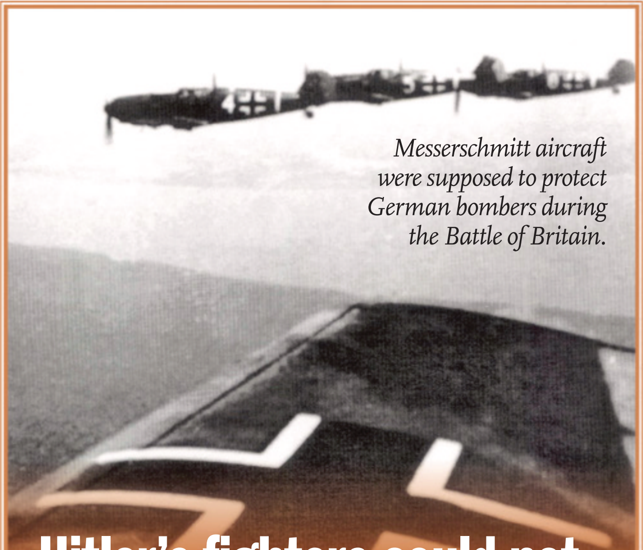
Aircraft passed the test

At the end of May 1936, the Spitfire would undergo a major trial with the Air Ministry, which had plans to incorporate the fighter plane into the Royal Air Force. Captain Humphrey Edwardes-Jones was appointed as the pilot to determine the plane's destiny.

The flight ran smoothly, and immediately after landing, Edwardes-Jones went to see Wilfrid Freeman from the Air Ministry to share his immediate opinion on the plane. He had barely uttered a word before he was interrupted. "All I want to know now is whether you think the young pilot officers will be able to cope with such an advanced plane", Freeman asked. "Yes", replied Edward Jones. Shortly afterwards, Freeman made an order for 310 Spitfires, the first of which was to be delivered in September 1937 and the last in March 1939.

During the spring and summer of 1936, the Spitfire charmed the English population with a series of shows, and from all sides the plane was flooded with praise. People were in awe of the fighter plane's beautiful clean lines, and connoisseurs were excited by its acrobatic skills, calling it "a ballerina in flight". Even the industry magazine *Flight*, which wasn't known for its enthusiastic superlatives had to give in: "It is claimed – and the claim seems indisputable – that the Spitfire is the fastest military plane in the world".

Mitchell had hardly any strength left to accept the accolade he was receiving. The cancer had returned with renewed force, and by the end of 1936 Mitchell was very weak. But even though his life was a painful hell, he went to his office daily to muse over Spitfire drawings. In the spring of 1937, his health deteriorated further. On 6th June, 1937, he slipped into unconsciousness, and five days later, he died at the age of 42. At the funeral, three RAF aircraft flew in formation over the cemetery in Southampton and tipped their wings as a gesture to the man who had designed the ground-breaking Spitfire.



Messerschmitt aircraft were supposed to protect German bombers during the Battle of Britain.

Hitler's fighters could not overcome the Spitfire

Although the Messerschmitt Bf 109 was more heavily armed and flew higher and faster than the Spitfire, it could not beat its British rival.

On paper, the German Messerschmitt Bf 109 fighter should have been the Spitfire's superior. Its powerful weapons, high speed and high altitude made the plane a terrifying opponent. With its direct fuel injection, Messerschmitt Bf 109 provided a smooth flight, whereas the Spitfire's engine coughed and spluttered due to its carburettor system.

On the other hand, the manoeuvrability of British fighters was unmatched. Under pressure, the pilot could shake off his opponent by performing a half roll, following up quickly with a dive.

Pilots loved new fighter

Supermarine's promise to deliver the first aircraft by September 1937 proved unrealistic. The Spitfire's all-metal build made it unique among British aircraft, so its road from prototype to full production was a long one. The situation wasn't helped as Supermarine had never tried to build aircraft in such large numbers before. To the Air Ministry's deep frustration, Supermarine delayed the date of the first delivery.

A leather helmet with built-in microphone and goggles were part of the pilot's standard equipment.

Nevertheless, in the spring of 1938, the Ministry increased the order from 310 to 510 planes. The need to get the planes up and running was critical – Hitler was no longer hiding his ambitions. In March 1938 German troops marched into Austria. The Führer threatened to occupy Czechoslovakia, and it was evident that a big European war was on the horizon.

In an attempt to boost production, Supermarine entered into agreements with a host of subcontractors to build each part of the Spitfire. Almost 80 companies were engaged in the production of wings, tail pieces and engine suspension. Yet, the factory remained hopelessly behind schedule.

It wasn't until 4th August, 1938 that Supermarine delivered its first Spitfire to the RAF, but then other aircraft followed quickly. In spite of the wait, pilots were thrilled, and it wasn't long before the plane had gained glory as rumours about its excellence spread far and wide. Pilots spoke with awe about the Spitfire, and for many Britons,the fighter became their main reason for enlisting with the RAF.

One such example was HR Allen, who applied to be a pilot immediately after seeing a picture of the plane:

"It was an aircraft quite out of this world", he enthused, and after his debut flight in a Spitfire, Allen was not disappointed.

"If you wanted to turn, you just moved your hands slowly and she went. She was really the perfect flying machine", was the view echoed by George Unwin, who flew with 19 Squadron. He was far from alone in his admiration for the fighter. It was as if man and machine melded into one.

A sense of connectivity was highlighted by several pilots, and as one of them, Bob Doe, said:

"You're not flying an aeroplane; you've got wings on your back".

The Spitfire's manoeuvrability was in a class of its own compared to other RAF planes. Goodson described how the plane's manoeuvrability made it a pleasure to smoke – though smoking was strictly forbidden on board:

"If I drop my cigar, instead of groping around on the floor, I'd move the stick a fraction of an inch, the Spit would roll over and after that I'd catch the cigar as it came down from the floor".

Soon, however, enthusiasm was replaced by the bloody realities of war as the Germans began air raids over England in 1940.

GERMANS WERE HUMILIATED BY THE BRITISH

After the outbreak of World War II in September 1939 Germany marched from victory to victory, and only the British stood on the way of a Europe united under Hitler. The Germans therefore planned to invade Britain, and the first step was to gain air superiority and crush the RAF. The Germans considered the task doable – until they saw the Spitfire in action.

On paper, the British faced certain defeat in any test of strength against the Germans, as the Luftwaffe was the superior of the RAF in terms of both men and equipment. But when German bombings escalated on 10th July, 1940, and German fighters approached the British coast for what would develop into the first major air battle in history, they were met by a swarm of Spitfire and Hawker Hurricane fighters.

The two types of fighter were more than a match for the Luftwaffe's heavy bombers, and as the Battle of Britain progressed, the Germans had to face the fact that they had underestimated the RAF pilots and their machines.

The Germans even had an advanced fighter, the Messerschmitt Bf 109, which was both faster and more heavily armed than the Spitfire – yet when it came to manoeuvrability, the new British aircraft was incomparable. The plane became the symbol of victory in the Battle of Britain – in combination with the so-called Dowding system, a network of radar and flight observers, the Spitfire successfully defended Britain.

For the Germans, on the other hand, the Spitfire became synonymous with total humiliation. When the head of Luftwaffe, Hermann Göring, asked one of his very best pilots what he thought was needed to turn the tables, he received a response that left him red with rage:

"Give me a squadron of Spitfires".

NAME **REGINALD MITCHELL**

TITLE AIRCRAFT DESIGNER

1895-1937

German trip inspired plane

Not many people would have thought that Reginald Mitchell would become one of Britain's greatest aircraft engineers when he apprenticed with locomotive manufacturer Kerr Stuart & Co, aged 16. The inquisitive boy, however, took the time to absorb as much technical knowledge as possible. Mitchell worked in the company's drawing room at the end of his apprenticeship and took concurrent technical and math courses at night school. With his new skills in the bag, the young Briton was perfectly placed to apply for a position at the Supermarine aircraft manufacturer, where he quickly rose from assistant to chief engineer.

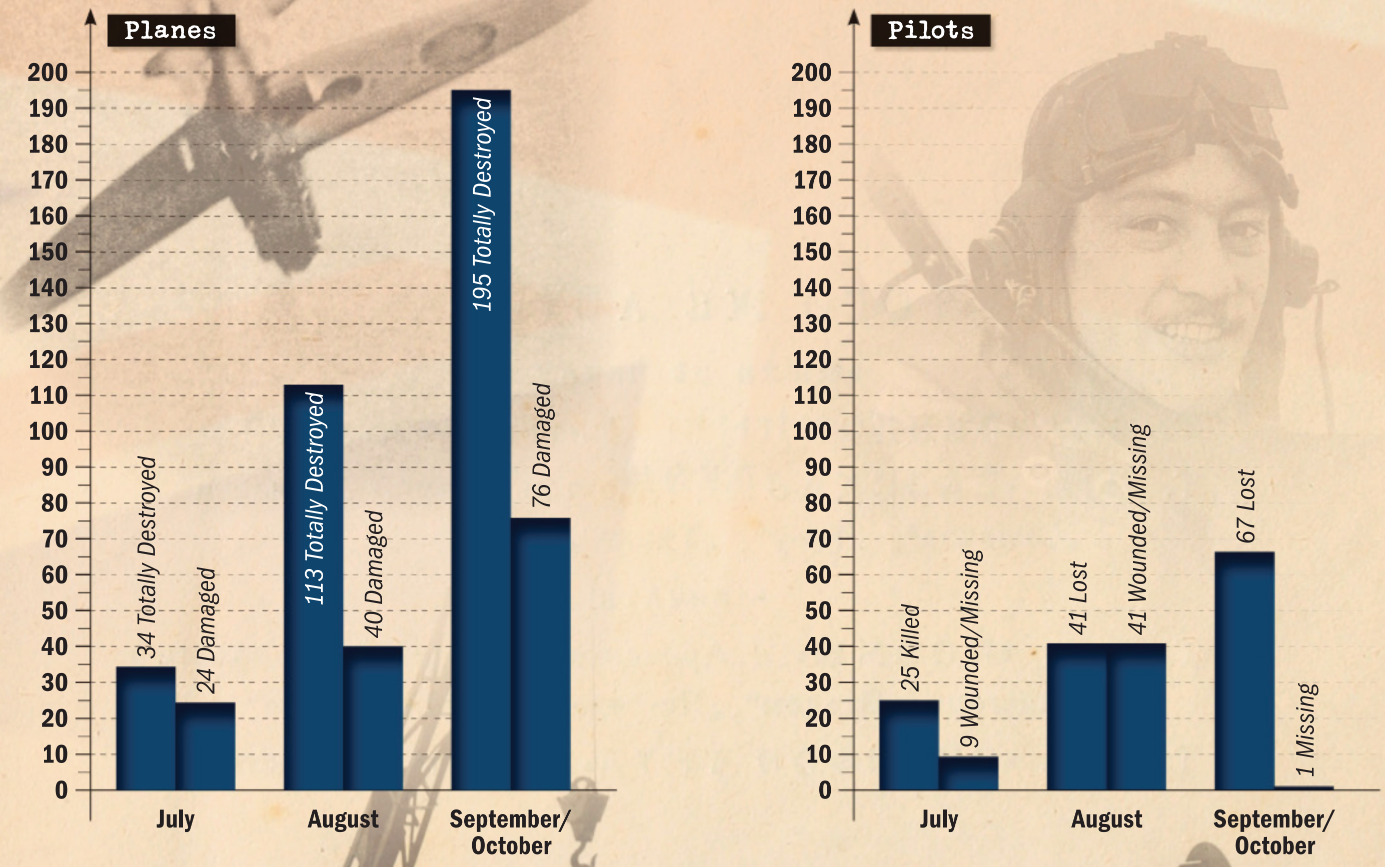
After being diagnosed with cancer, Mitchell travelled to Germany in 1934. Here, the aircraft engineer realised that the RAF was no match for the Luftwaffe, and he recognised that Britain had to create a powerful fighter plane to counter any German attack.

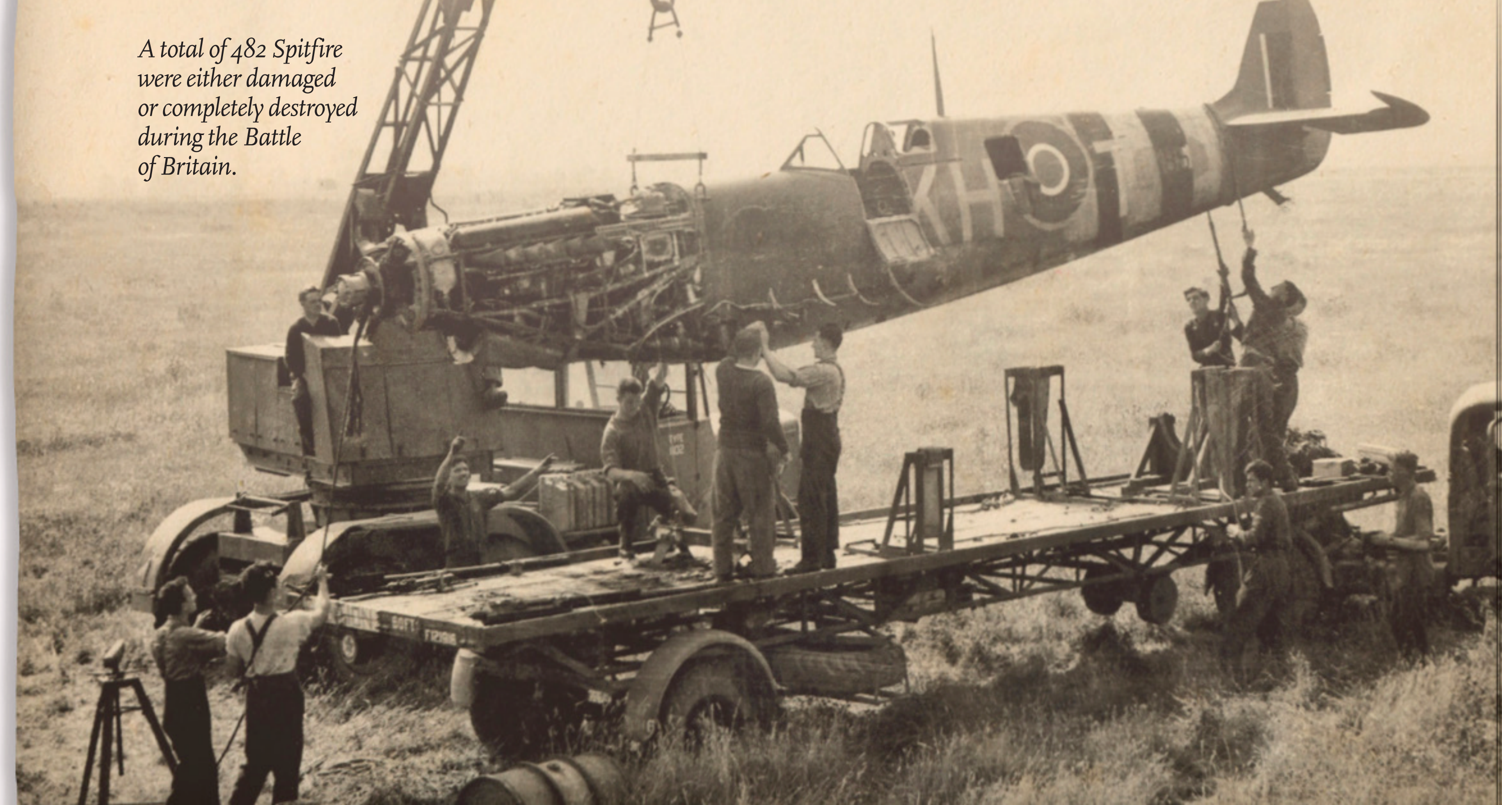
- **Qualified as a pilot in 1934.**
- **Had a school named after him in 1989.**

One in three British fighter pilots killed sat in a Spitfire

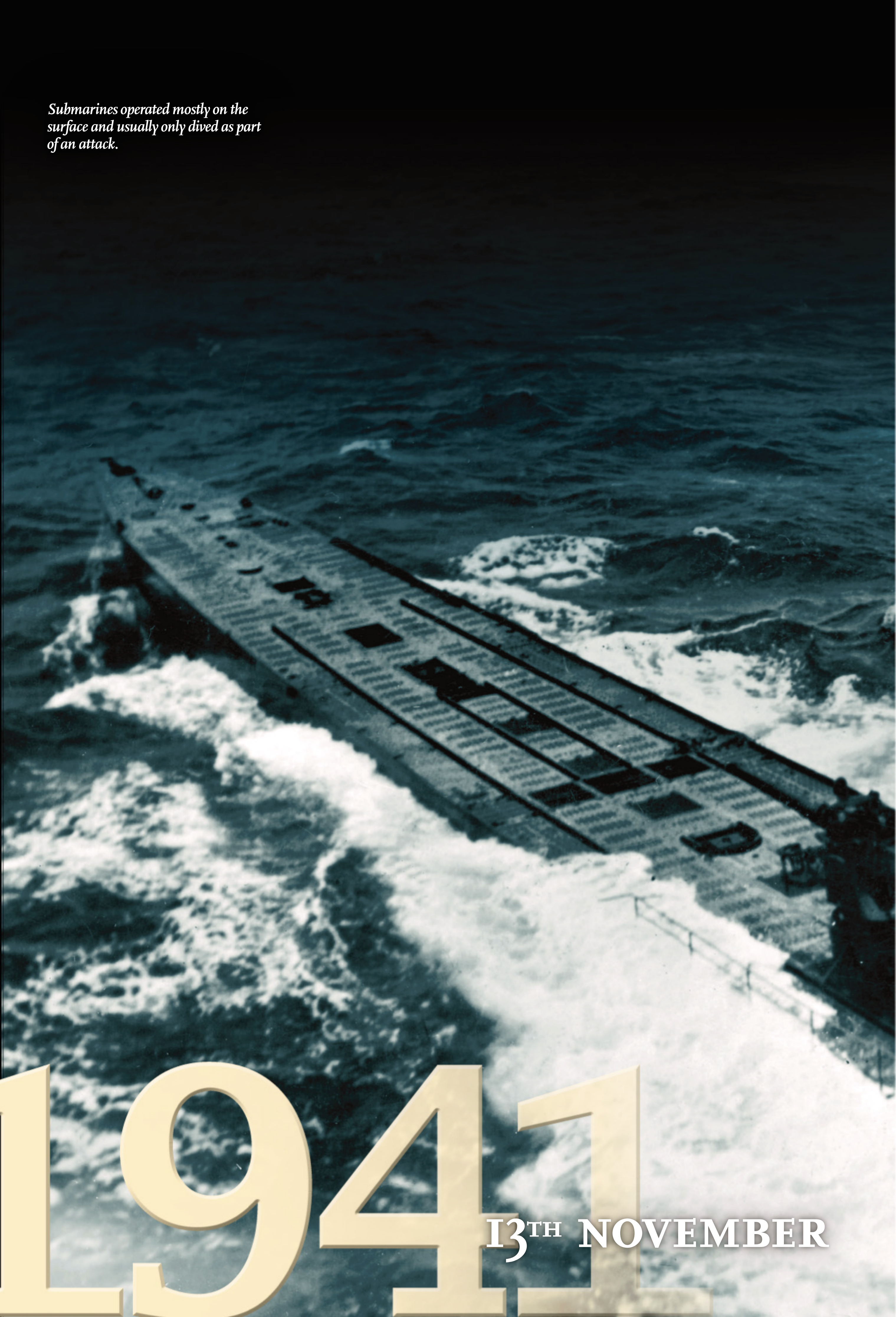
During the Battle of Britain in 1940, the loss of both Spitfires and pilots grew month by month. Nearly a third of all British fighter pilots who died during the four-month battle were in a Spitfire. The Luftwaffe lost a total of 1,887 planes and 2,662 crew during the air attacks.

Loss of Spitfires during the Battle of Britain





A total of 482 Spitfire were either damaged or completely destroyed during the Battle of Britain.



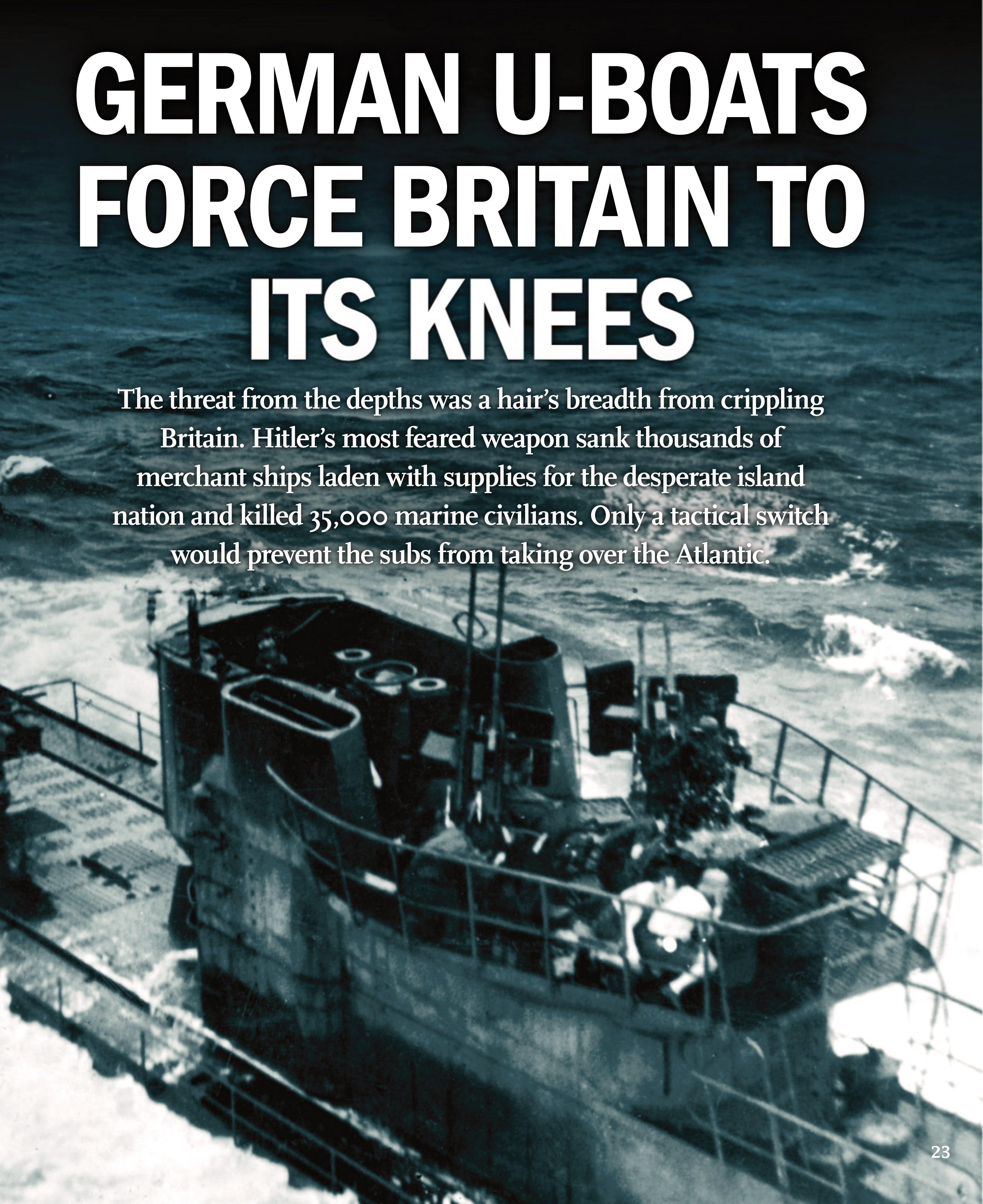
Submarines operated mostly on the surface and usually only dived as part of an attack.

1941

13TH NOVEMBER

GERMAN U-BOATS FORCE BRITAIN TO ITS KNEES

The threat from the depths was a hair's breadth from crippling Britain. Hitler's most feared weapon sank thousands of merchant ships laden with supplies for the desperate island nation and killed 35,000 marine civilians. Only a tactical switch would prevent the subs from taking over the Atlantic.



North Atlantic, 1941

THE STAGE IS SET

NORTH ATLANTIC

After the Battle of Britain, Hitler abandons the idea of invading Britain. Instead the Führer believes that if the Germans can prevent vital convoys from the United States and Canada from reaching Britain, he will starve the island to submission. Hitler will achieve his goal using a much-feared weapon: U-boats.

On the afternoon of 13th November 1941. The aircraft carrier *Ark Royal* had ferried her cargo to Malta and was on her way back to Gibraltar.

As she travelled through hostile territory, there was a huge risk of attack from German aircraft and subs, but *Ark Royal* had already withstood several bomb attacks.

At 15.40, the sonar operator of the British destroyer *Legion* heard an unusual sound. He assumed it was the propellers of one of the six other surrounding destroyers. But a minute later, a blast was heard from *Ark Royal's* starboard side. The explosion caused the ship to violently list to one side. The power went out, oil spewed, and smoke threatened to choke the crew.

Captain Loben Maund moved urgently from the deck to the bridge to discover that a torpedo had hit the aircraft carrier between its fuel tank and ammunition room. The captain knew that an evacuation was inevitable and told the Destroyer *Legion* to lie to the side of the ship and take the *Ark Royal's* 1,500 crew on board. At the same time, the other escort ships went on the hunt for the U-boat.

On board *U-81*, the sound of the full hit had roused the crew. Anyone who wasn't on duty ran down to the sub's bow. The heavier it was, the faster it went down.

The men could hear a terrifying sound: "ping... ping... ping" – a sign that British sonar had reflected off the submarine's hull; and immediately afterwards a battleship's propeller could be heard over their heads. *U-81* sailed in a zigzag, alternately rising and diving to escape the sonar. 130 depth charges rained down on the submarine, but *U-81* succeeded in sneaking away to continue its pursuit of the British merchant ships and warships. In total the U-boat would send 26 Allied vessels to the seabed in the Mediterranean and Atlantic Ocean before an American depth charge finally hit it in April 1944.

The success of *U-81* and many other German submarines came as no surprise to Admiral Karl Dönitz, commander of the German submarine fleet. Even before the outbreak of war,

1891-1980

NAME **KARL DÖNITZ**

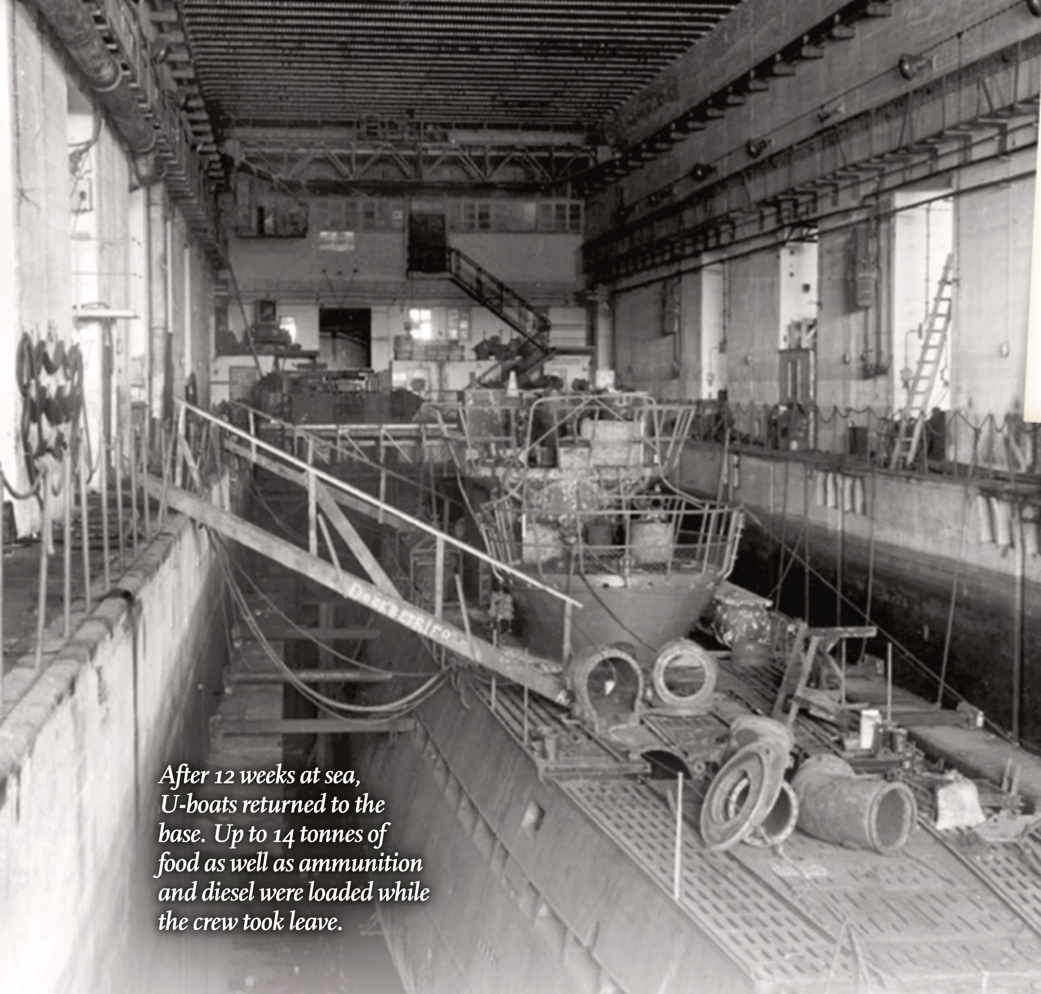
TITLE COMMANDER-IN-CHIEF OF THE KRIEGSMARINE

Admiral won the respect of his men

Karl Dönitz, who commanded the German submarine fleet, had the habit of inquiring into his men's private lives and sending congratulatory telegrams to all newly born fathers in the U-Boot-Waffe – even if they were at sea far from Germany. His concern made him popular among his men who called the admiral "Lion". Dönitz acknowledged them in turn by calling them grey wolves after their grey boats and leather uniforms.

Dönitz started on the *Breslau* in 1914. Two years later, he was promoted to first lieutenant and switched to the submarine service. Throughout the years, he climbed the ranks, and by 1939 had the rank Commander of the Submarines. In 1943, Dönitz assumed command of the entire Kriegsmarine. In his political testament, Hitler appointed the admiral as his successor, and he led Germany in its last days. At the Nuremberg Trials, Dönitz was sentenced to 10 years in prison – a sentence he never accepted until his death in 1980.

- **Served in submarines during World War I.**
- **Commanded the German submarine fleet from 1935.**



After 12 weeks at sea, U-boats returned to the base. Up to 14 tonnes of food as well as ammunition and diesel were loaded while the crew took leave.

The German submarine base in Brest, France, was reinforced with concrete five metres thick and impervious to Allied bombs despite a series of raids.

he'd predicted that submarines would play a crucial role. Britain was dependent on food, military equipment and fuel from the United States in order to resist a German invasion. Once Britain had been isolated, it would be a race to starve the British into submission by sinking more supplies than they could replace.

Admiral begged Hitler for submarines

Dönitz believed the German fleet needed to sink merchant ships with a total weight of about 700,000 gross tonnes a month – equivalent to two million cubic metres of freight – to force the British to their knees. The admiral estimated that he needed 300 subs to fulfil that task. But Hitler, who was prone to seasickness, was initially lukewarm at the significance of submarines. “On land I am a hero. At sea I am a coward”, he said.

Still, the Battle of the Atlantic began in 1939. First Lord of the Admiralty Winston Churchill began a blockade of Germany on 26th September. Hitler took up the challenge using his U-boat fleet to retaliate.

But the war had started before Hitler had expected, and only 57 subs were combat-ready, far fewer than Dönitz desired. The majority were also smaller vessels that could only reach targets in the North Sea before returning home. Consequently, Dönitz asked Hitler for permission to modernise the fleet with the new type VII submarine, which had an operating radius of more than 10,000 kilometres, allowing it to operate in the Atlantic for longer periods.

This gold medal was one of the German war marines' major honours.

Hitler also changed his opinion about the war at sea when on 14th October, 1939 the German sub *U-47* sank the British battleship *HMS Royal Oak*, which was anchored in the Scapa Flow base in Scotland. The sinking was not of major strategic importance, but it was a propaganda victory that gained the U-boats' respect among Germans while instilling a feeling of fear into the British.

At the same time, the Germans lost several large surface ships during the early war period, not least *Bismarck* in 1941. Because subs proved to be efficient, plus cheaper and faster to produce than surface vessels, Dönitz convinced Hitler to invest more in underwater warfare.

The decision was popular in military circles, because a host of young German men desired service in the U-boat fleet above any other. Service on submarines was also considered the most honourable. Training was long and the prestige high, although there was not much glamour in life at sea itself: when the sub was at sea, men could look forward to 12 weeks in a crowded cabin without windows in the company of 50 smelly and stressed men. At its widest point, the vessel measured five metres, but most of the space was occupied by engines, batteries, torpedoes, ammunition and supplies.

Everything was always wet

Being on board a submarine was also not for landlubbers; most of the time, the vessels sailed on the surface, where the waves buffeted the sailors back and forth. Four men kept lookout for air attacks from the command tower, and when the door to the tower was open during the North Atlantic's frequent storms, sea water got into the cabin. Even though the water was pumped away, everything was constantly wet.

The long voyages also meant that the greatest threat to morale and unity was not the enemy's warships, but

SUBMARINE

Two models served distinct roles

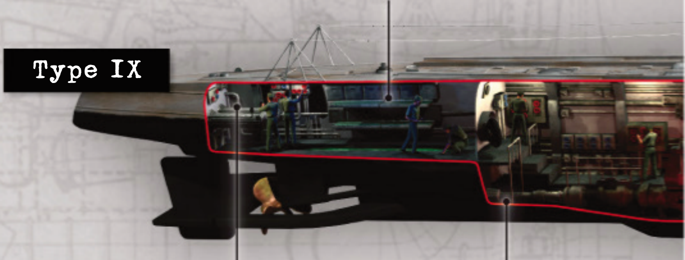
German engineers couldn't build a single U-boat that was both big enough to sail a long distance and yet small enough to dive quickly. The solution was to make two.

Shipyards received their first orders in March 1935, two months before Hitler officially broke the Versailles Treaty from 1919 and began to produce submarines.

Engineers had a difficult task. First, they had to construct a vessel that could dive quickly to carry both crew and equipment to safety. Originally, fleet command wanted a long-range boat. Small boats dive quickly, and large boats can carry a lot of fuel, supply and ammunition to make long voyages.

It proved impossible to construct a single sub with all these features. The solution was therefore to build two models.

Designers had no opportunity to consider the crew's desire for reasonable space and comfort.



Type IX usually carried 22 torpedoes. In some cases the sub was also used as a minesweeper.

Type VII
Rudder
Torpedo tube (1)

IX (model IXC)

Range, surface	11,000 nautical miles
Range, submerged	63 nautical miles
Length	76.8 metres
Draft	4.7 metres
Weight	1,232 tonnes
Speed, surface	18.3 knots
Speed, submerged	7.3 knots
Electric engines	2 x 500 hp
Diesel engines	2 x 2,200 hp
Crew	55

BIG BROTHER COULD SAIL FAR

With a range of 11,000 miles (20,400 km), the big brother of the German submarine fleet could operate across the Atlantic and even to the Indian Ocean. The IX model was valued for its spaciousness but feared because it dived slowly. 194 were launched.

VII (model VIIC)

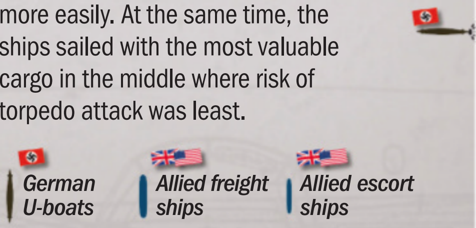
Range, surface	6,500 nautical miles
Range, submerged	80 nautical miles
Length	67.1 metres
Draft	4.8 metres
Weight	865 tonnes
Speed, surface	17 knots
Speed, submerged	7.6 knots
Electric engines	2 x 375 hp
Diesel engines	2 x 1,400 hp
Crew	48

LITTLE BROTHER DIVED QUICKLY

The smaller type VII dived swiftly and could usually escape Allied warships. On the other hand, the narrow space was a nightmare for the men. The VII model was the backbone of the German submarine fleet with over 700 sea-going vessels deployed during the war.

Ships were safest in square convoys

Traditional convoys that travelled in long rows were quickly abandoned. Instead, the Allies sailed in a square formation so the accompanying warships could protect the cargo ships more easily. At the same time, the ships sailed with the most valuable cargo in the middle where risk of torpedo attack was least.

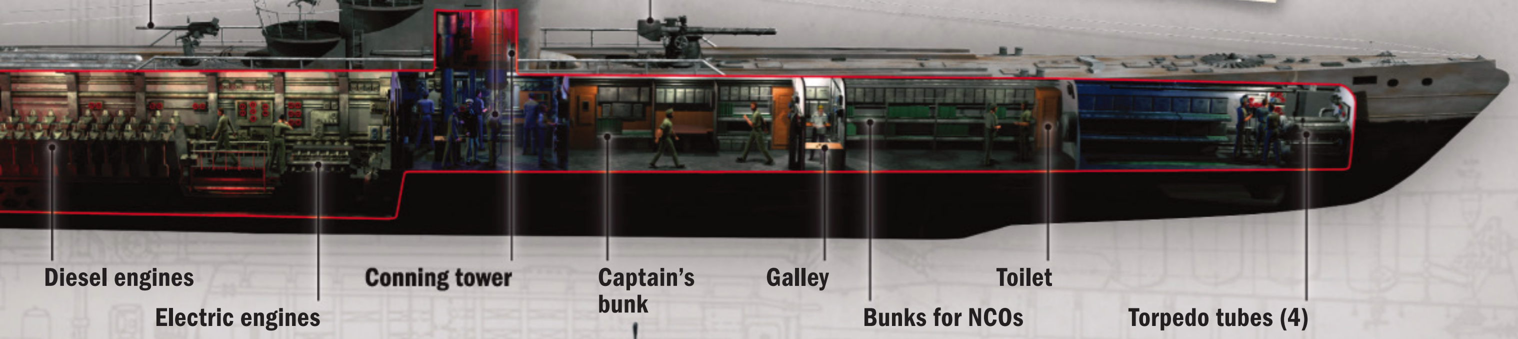


boredom. Time went slowly while the captain searched the ocean for prey. Even reading was often impossible because the batteries needed saving. Batteries were needed to operate the electric motor while the diesel engines were switched off during diving. Fights sometimes broke out among frustrated crew members while waiting.

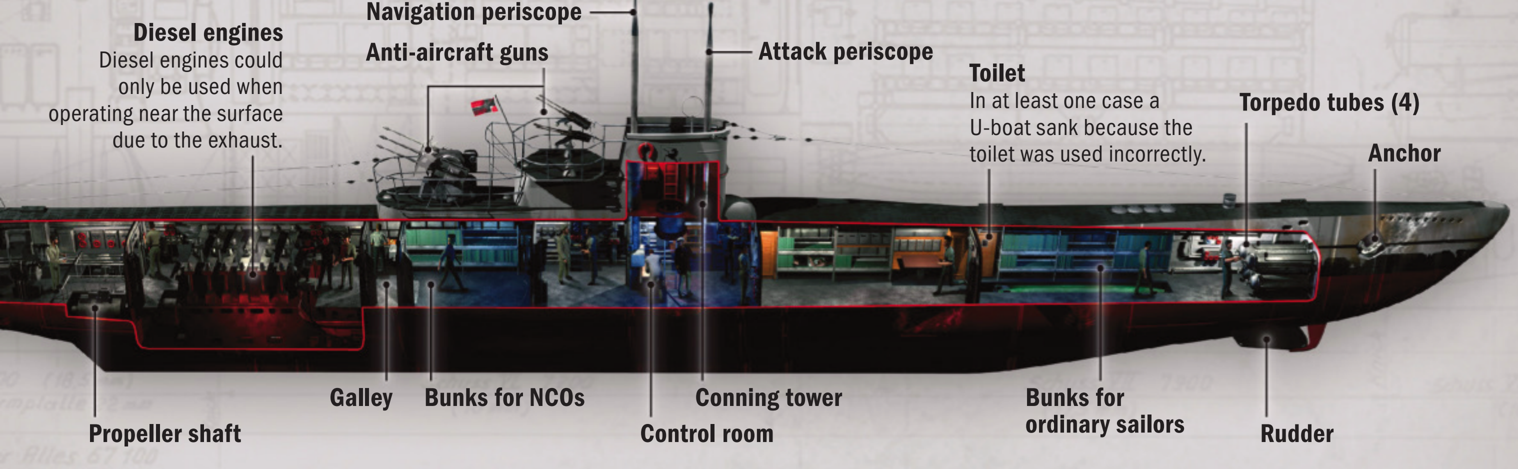
In the first year of the war, German submarines were also in a hurry to sail to the north of Scotland to reach the convoys in the Atlantic. But after the conquest of Norway and especially France in May 1940, U-boat bases were moved to the Norwegian and French Atlantic coasts. Precious sailing time was saved, and the Germans seemed to have a real chance of isolating the British and winning the Battle of the Atlantic.

Before the war, Britain imported 59 million tonnes of food and raw materials per year plus all the oil it needed. Thanks to U-boat attacks, that number had fallen to just 12 million

The space on board was so cramped that the crew had to take turns sleeping. The submarine's torpedoes were also stored in the same room.

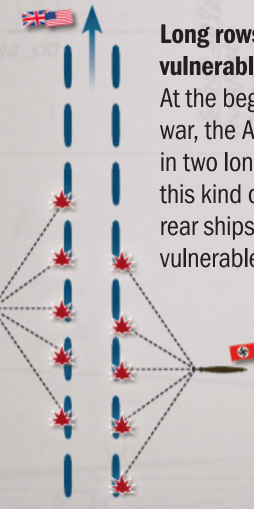

Attack periscope
Navigation periscope
Anti-aircraft gun
Radar
Control room
Deck gun
Diesel engines
Electric engines
Conning tower
Captain's bunk
Galley
Bunks for NCOs
Toilet
Torpedo tubes (4)

Control room
Early models had a third periscope in the control room, which disappeared in Type IXC.

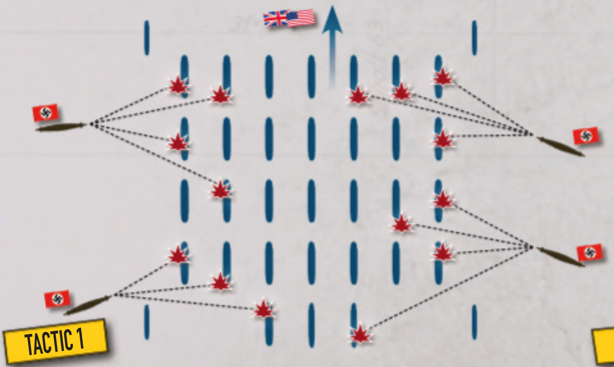

Navigation periscope
Anti-aircraft guns
Attack periscope
Diesel engines
Toilet
Torpedo tubes (4)
Anchor
Galley
Bunks for NCOs
Conning tower
Control room
Propeller shaft
Bunks for ordinary sailors
Rudder

Diesel engines
Diesel engines could only be used when operating near the surface due to the exhaust.

Toilet
In at least one case a U-boat sank because the toilet was used incorrectly.

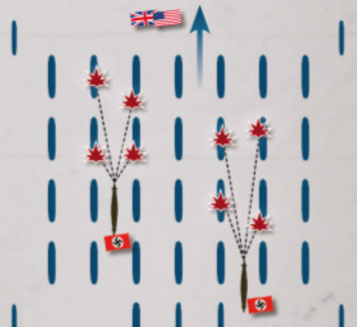


Long rows proved vulnerable
At the beginning of the war, the Allies often sailed in two long rows. But with this kind of convoy, the rear ships were especially vulnerable to attacks.



TACTIC 1

Wolves attack from the flanks
The square convoys were attacked from their sides. U-boats fired torpedoes from a long distance and hoped that some would prove effective.



TACTIC 2

Brave captains hid in the middle
The boldest commanders sailed in between the ships under cover of darkness and fired torpedoes from close range before diving.

tonnes by the end of 1940. The British also felt under siege, and there was a fear that the war would be lost on the home front where people were living on starvation rations: "Nobody really understood how close we were actually losing the war due to lack of food", a business economist revealed later.

Wolf packs attacked in the dark

Until 1941 the success of submarines was an effective offensive tactic. The whole of the Atlantic was divided into 10 x 10-kilometre quadrants. Each quadrant was denoted in two letters and four digits, so the radio operator could receive a coded message revealing where another sub had sniffed out prey, after which the U-boats met in so-called wolf packs.

The submarines positioned themselves in a row across the convoy route, ready to attack the following night. Up to 30 submarines would surface simultaneously to launch a coordinated attack. Germans used battery-powered silent torpedoes that typically hit the side of the target ship. But it was best if the torpedo exploded just below its hull. The explosion forced the water away leaving a vacuum, so the hull expanded. When the water returned, the keel broke. At the outbreak of war, however, the Germans often encountered problems with failing igniters and defective balance chambers. Later, engineers evolved torpedoes to search out the noise from the propellers; otherwise they continued through the water without exploding until they hit something.

A brave captain was able to navigate between the rows and torpedo the largest ships that were usually located in the middle. The submarine lay on the surface where it was invisible to the Allies' radar. After the attack, the captain sometimes took cover underneath a merchant ship, where the U-boat was almost impossible to detect, until the panic of the convoy had subsided. Then the attacker stole quietly away.

Hitler threatened Allies with torpedoes

The audacious raids were well on the way to forcing Britain to its knees. Prime Minister Winston Churchill later wrote that, "The only thing that ever really frightened me during the war was the U-boat peril". From June to October 1940, the grey wolves sank hundreds of Allied ships, and the submarine crews called the period "Die Glückliche Zeit" (happy times). Hitler was a complete convert to the U-boat war by the time he stated, "Whoever believes that he can help England should know one thing in any event: any ship, with or without escort, that comes in front of our torpedo tubes will be torpedoed!"

The Germans repeated the threat when the country declared war on the US in December 1941. Now Dönitz could – with great pleasure – initiate his attack on the Americans with Operation Paukenschlag (drum beat). With the help of supply submarines, so-called dairy cows that could resupply U-boats with food and fuel, the wolf packs could reach the US East Coast. Here, Americans had yet to start sailing in convoys, and with no blackout orders, their ships were easy prey for U-boats to find and sink up and down the coast.

At the same time, the Germans broke Allied codes in the summer of 1942. Thanks to the intercepted information, U-boat command knew many of the convoys' routes, as well as knowing which ones were most vulnerable because of a lack of escort ships.

During an average month in 1942, merchant ships with a total weight of 650,000 gross tonnage – equivalent to more than 1.8 million cubic metres of goods – were sunk. The number was very close to Dönitz's target of how much was required to cripple Britain. And thanks to efficient U-boat production, by the beginning of 1943 the fleet could boast no fewer than 400 operational submarines, of which around half were in the front line.

Still, it turned out not to be enough. The missions were many, the Atlantic was huge, and the Allies had begun to get wise to German tactics. At the same time, a number of new technological inventions and tactical ideas made an impact.

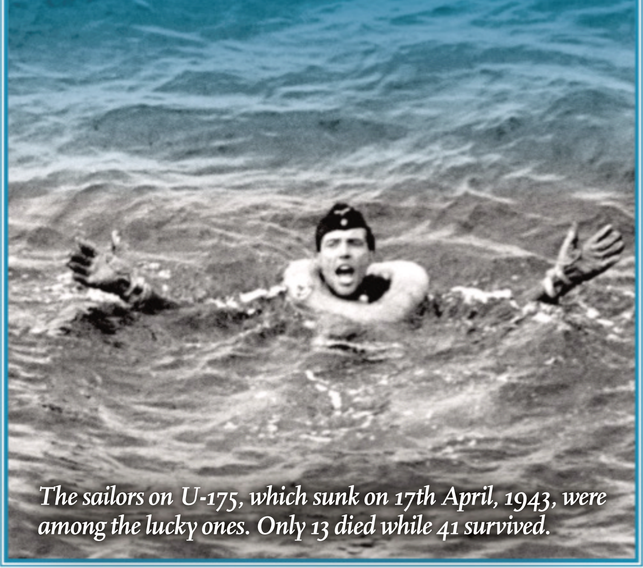
Sailors' rescue vests could be inflated by mouth or with compressed air from cartridges.

Eight out of 10 died at sea

The crew of a wrecked submarine was doomed. When the boat sank, it almost certainly became a coffin.

All sailors in German U-boats were taught how to use their "tauchretter", a life jacket with breathing apparatus that in theory could save them from certain death. But in practice, the vest was useless, because it was very difficult to get out of a sub at the bottom of the ocean. And should it prove possible, the sailor would probably die from decompression sickness (the bends).

Some sailors escaped the death-bound submarines before they sank. Yet losses in the U-boat fleet were huge – around 80 percent of German sailors aboard submarines died in service.



The sailors on U-175, which sunk on 17th April, 1943, were among the lucky ones. Only 13 died while 41 survived.

Depth charges could tear a sub's hull

The Allies already thought it was safest to cross the Atlantic in convoys, which typically consisted of 20-60 merchant ships. Each convoy was shaped like a square, so the ships occupied the least amount of space on the ocean – this made them harder to spot, yet also easier to defend for the ships escorting them. U-boats lay low in the water, and a convoy might be missed from the command tower from as little as 30 kilometres away. On the other hand, the Germans had radio equipment that could intercept communications from British ships. And when the vessel came closer, the Germans could hear the noise from propellers and engines using a so-called hydrophone, an underwater microphone.

After merchant ships had been attacked, the hunt turned on to the grey wolves, which the British initially performed using the ASDIC sonar system. It was based on an acoustic technique where sound waves were emitted from a dome

Crew members kept look out for merchant ships through the periscope while the submarine sailed near the surface. The U-boat only dived and made ready to attack when a ship was discovered. Often other submarines were called up, so U-boat hunters could attack in groups.

beneath the ship – these would then bounce back if they hit any underwater objects. The echo allowed the system to calculate the distance, direction and depth of the object. ASDIC could not reveal ships on the surface, but during 1941-42 ships were also equipped with radar that could reveal objects on the sea surface via microwave emissions.

When the escort ships had located a sub, the crew tried to destroy it by dropping depth charges. The Allies were handicapped, however, by the fact that depth charges could only be rolled out from the rear deck. German U-boat captains simply had to manoeuvre out of the way.

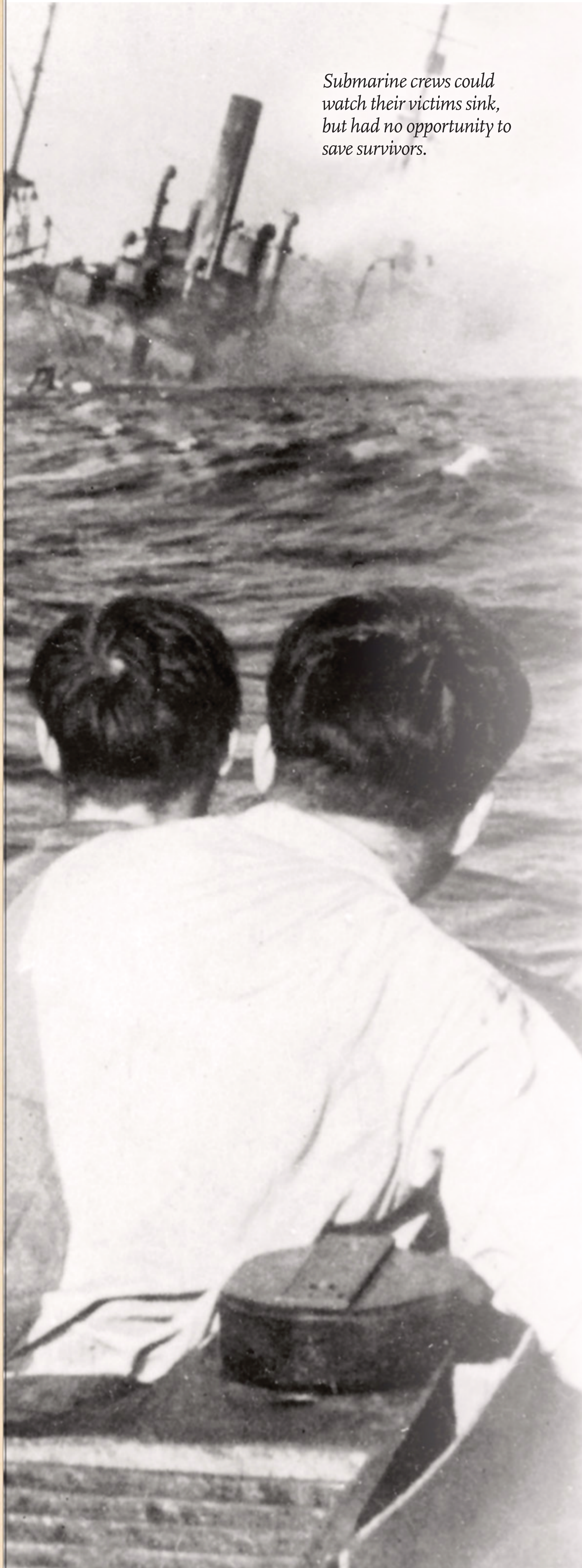
Normally, a depth charge had to detonate at four to six metres from a U-boat to breach its hull. Detonations from 7-15 metres would damage the sub, while explosions at a greater distance had a primarily psychological effect on sub crews.

As a rule, it wasn't a single well-placed depth charge that would sink a sub, but an intense bombardment involving many charges. Escort ships also tried to drop depth charges in a diamond shape around the submarine, so it would maximise the chance of damage. The bombs' main disadvantage was that they were primed to explode at a specific depth. Plus, if the attack failed, the depth charges created so much disturbance in the water that it was difficult to restore sonar contact.

But from the end of 1942 the British installed a newly developed mortar – Hedgehog – on the escort ships. The mortars fired 24 depth charges from the ship's bow, which only detonated when they hit something. If one charge was triggered, then the rest exploded, which increased the weapon's effectiveness. Thanks to Hedgehog, it became harder for subs to escape undamaged from an attack on an Allied convoy.

At the same time, the threat from the air grew. At the start of the war, subs could settle in the middle of

Captain's cap – an elite group of just three percent of German U-boats sank 30 percent of all ships.



Submarine crews could watch their victims sink, but had no opportunity to save survivors.

the Atlantic, out of reach of enemy planes. Now, however, long-range aircraft with bases in North America and the British Isles were capable of flying out to protect the convoys along most of their route.

At first, pilots found it tricky using radar to locate the U-boats in the great expanse of ocean before they could dive. The Germans introduced a snorkel system, so the submarines could remain immersed to avoid the radar. But gradually, the Allies developed their advanced radar systems so planes could even spot a snorkel poking up out of the water. At the same time, the planes were equipped with the so-called Leigh Light (L/L), which automatically aligned with the radar to suddenly bathe a submarine in light in the middle of the night. The submarines had gone from hunters to prey.

At the end of the war, the wolf packs also suffered at the hands of aircraft carriers, which now provided permanent air cover, supplemented by merchant ships fitted with launch ramps for fighters. The submarines weren't armoured, so an encounter with bombs from an Allied plane could quickly have a fatal outcome. In total, about half of all U-boats sunk received their death blow from aircraft.

Submarines were chased for hours

As Allied superiority grew, the convoys were also reinforced with several escort ships, and the Allies established support groups of escort vessels patrolling around the convoy, so they could escape when under attack. As the support groups weren't associated with a particular convoy, they could continue chasing a submarine for hours while the convoy continued across the Atlantic.

Ultimately, however, the deciding factor was who could build the most vessels in the shortest time. When the United States entered the war at the end of 1941, the mighty American production facilities became a factor that the Germans could not match in the long run. The record was set when an American shipyard managed to build a merchant ship on assembly lines in four days. In addition, ship engines became more powerful, so the ships could outrun the U-boats.

The Allies' accelerated production helped turn the Battle of the Atlantic in their favour in just a few months around the turn of the year 1942-43. In May 1943 the Allies sank 41 submarines and the disaster was dubbed "Black May" by the Germans. Dönitz realised that the North Atlantic had now become too dangerous for his submarines, and on 24th May, he ordered them away from the North Atlantic convoy route.

Instead, the Admiral gradually deployed many of his vessels to remote hunting fields beyond the Caribbean and India and all the way to the Far East, where they docked at Japanese bases. But the submarines only enjoyed limited – and small – success in distant waters.

Terror tactics hadn't worked

The French U-boat bases were also exposed to heavy bombings from the air, and eventually the German submarines were displaced to bases in the Baltic and Norway. But here too, they were chased by the RAF. Many subs were sunk in the straits between Denmark, Sweden and Norway if they attempted to head out into the Atlantic.

The belief among those in the submarine fleet that this was a tactic worth pursuing dropped dramatically. But it wasn't the case with Hitler. In 1945, he sent new super type XXI and XXIII U-boats into the war. But the battle had long been lost. Also, the number of submarines wasn't enough for the previously successful tactic of hunting in packs to be used. Now the subs were lone wolves who scoured the sea and attacked alone, putting them at greater risk of being spotted and bombed by the Allies.

Some grey wolves still slipped into the Atlantic and hunted all the way to the US East Coast. Here one of the last U-boats was sunk by the US coastguard. It happened after Grand Admiral Dönitz had called off the fight on 4th May, 1945 with the words:

"Six years of U-boat war lie behind us. You have fought like lions. A crushing material superiority has forced us into a narrow area. A continuation of our fight from the remaining basis is no longer possible... Lay down your arms after a heroic battle without equal. We remember in deep respect our fallen comrades, who have sealed with their death their loyalty to the Führer and Fatherland... Long live Germany!"

The lone sub off the US coast never received the radio signal, and the whole crew drowned. The sailors were the last to die in the war.

A total of 28,000 German sailors died during the Battle of the Atlantic. Allies' losses were also severe. Over 5,000 vessels ended at the bottom of the ocean, most of which were sunk by U-boats. The total tonnage destroyed by the Germans was over 14 million tonnes, and about 35,000 Allied sailors lost their lives.

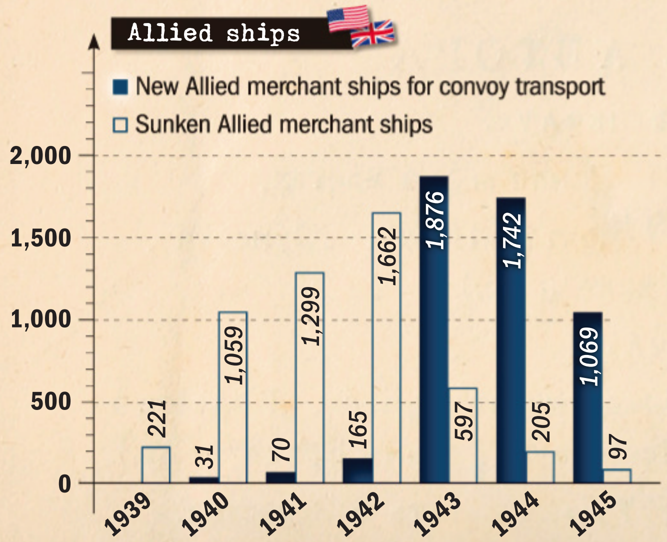
7 x 50 mm Carl Zeiss binoculars were standard issue on German subs.

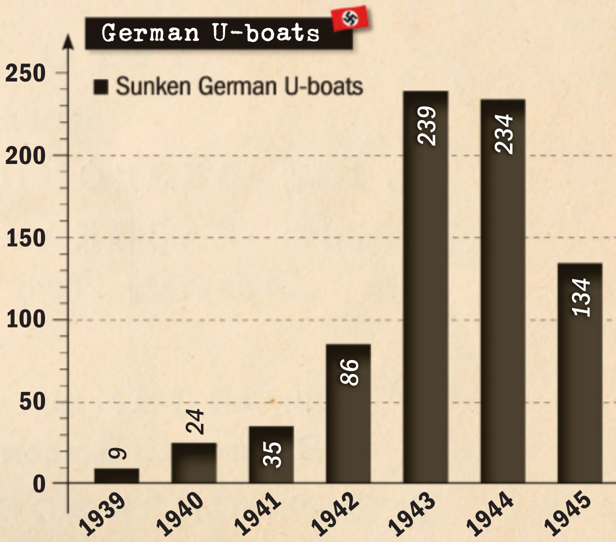
PERSPECTIVE

U-boats could not keep pace

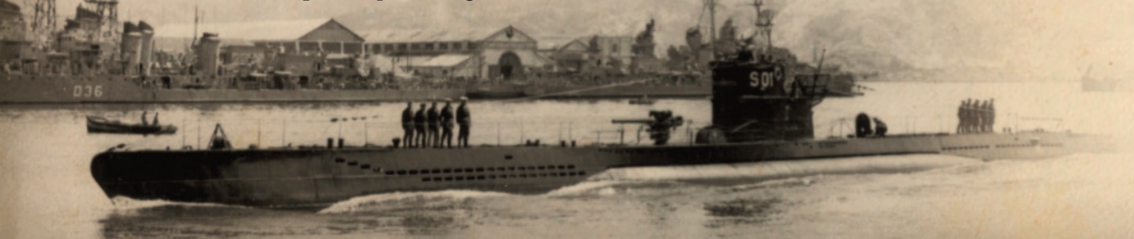
As US industry picked up speed, it produced so many new ships that the German subs had no chance of sinking enough to keep pace.

In the first year of the war, only the British managed to take a few German submarines out of action. But in the spring of 1943, development of new technologies and defensive techniques, including depth charges, had come so far that the Allies sank 41 subs in May alone. The massive losses continued throughout the war. At the same time, US production of new merchant ships peaked in 1943 and gradually exceeded the number of subs that the Germans could sink. Thus, the Allies could send convoys to Russia and especially Britain packed with supplies and soldiers. Soldiers from the US and Canada, together with the evacuated forces from Dunkirk, provided the nucleus of the army that landed in Normandy on 6th June, 1944 to begin the liberation of Europe.





German U-boats with bases in Norway and France found it increasingly difficult to attack Allied ship convoys crossing the Atlantic.



Engineers work on new types of ship in a yard in Britain. There were many ideas, but most had to be scrapped.

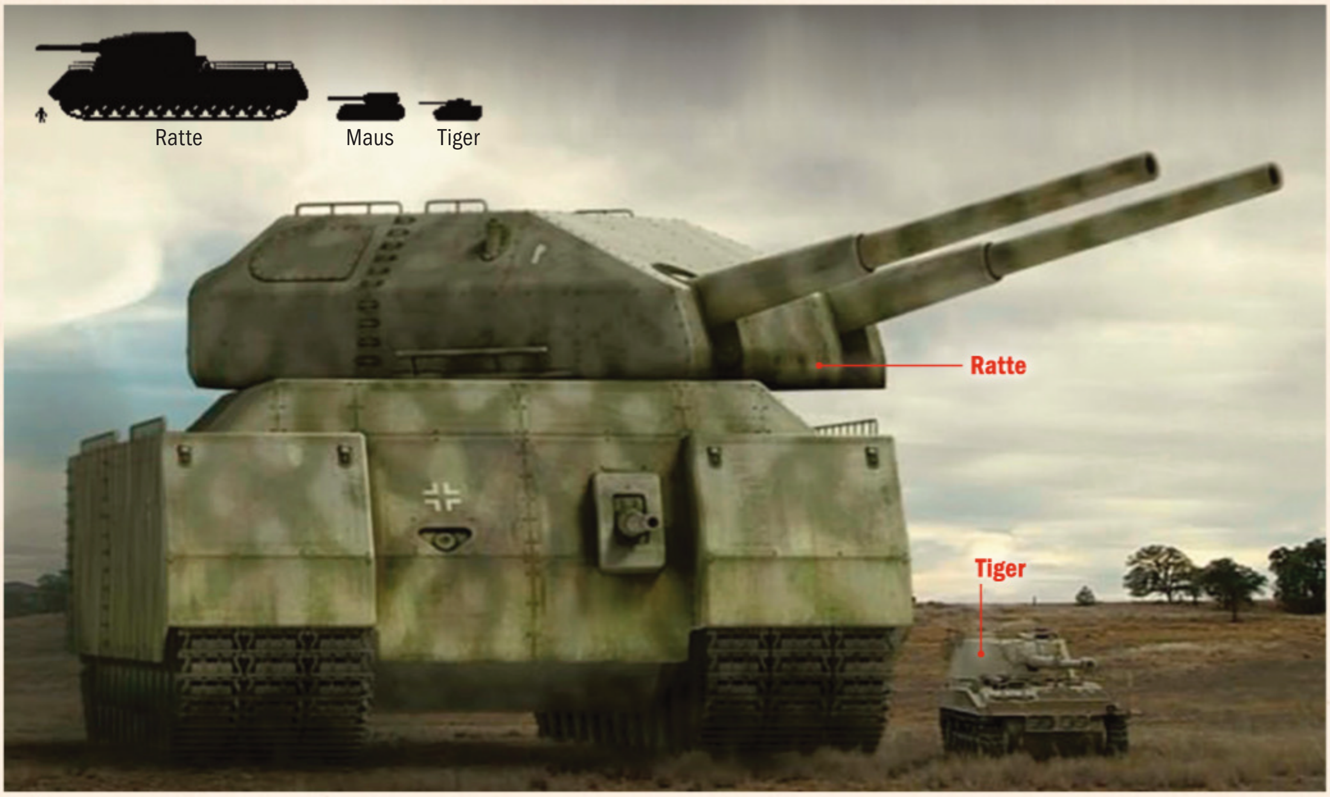
1941

WILD PROJECTS

FANTASY WEAPONS LEAVE THE DRAWING BOARD

As the fight on the battlefield waves back and forth, frazzled brains on both sides try to come up new weapons that can win the war. Some projects come to fruition, but many more creative weapons prove to be more dangerous to the user than to the enemy.

Nazi Germany had plans for an atomic bomb, *but the project was never given top priority. The technique chosen by the German physicist team demanded heavy water from Norway, and production was repeatedly sabotaged. Nevertheless, it was possible to build a test reactor in Haigerloch in south-west Germany. But before the work started, the Allies arrived in 1945 and dismantled the reactor (see picture).*



The super-heavy tank Ratte (rat) was so large *other German tanks like Tiger and Maus looked like toys next to it. Ratte would have weighed 1,000 tonnes and boasted a crew of at least 20 men. Hitler was excited about the giant tank, but when it proved too heavy to cross bridges while its size made it an easy target for air attacks, the project was shelved by Minister of Armaments Albert Speer in 1943.*

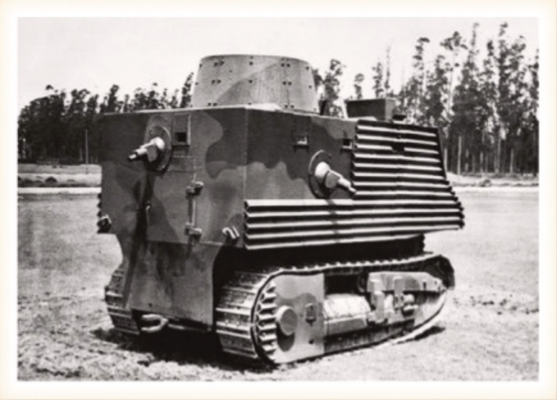
ON LAND

Giant projects were stillborn

Opposing land forces were often evenly matched during battles, so engineers were given the task of developing new versions of conventional tanks and powerful superweapons to tip the balance.

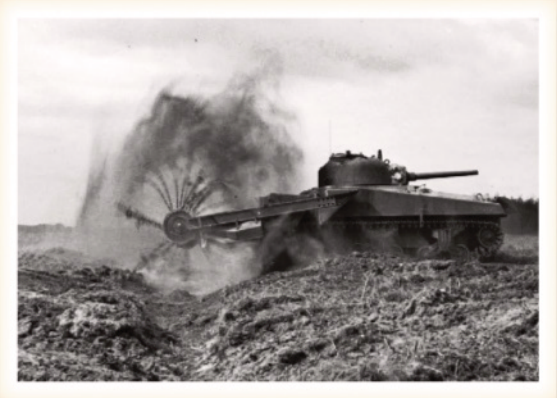
In Germany, Edward Grotte from the Krupp Group proposed a monstrous tank, while Bob Semple in New Zealand went in the opposite direction to design a mini-tank that could be cobbled together by handy amateurs. The tank also had a secondary role as a minesweeper.

However, all efforts on the battlefield would have been immaterial if the German dream of creating a Nazi atomic bomb had become reality.

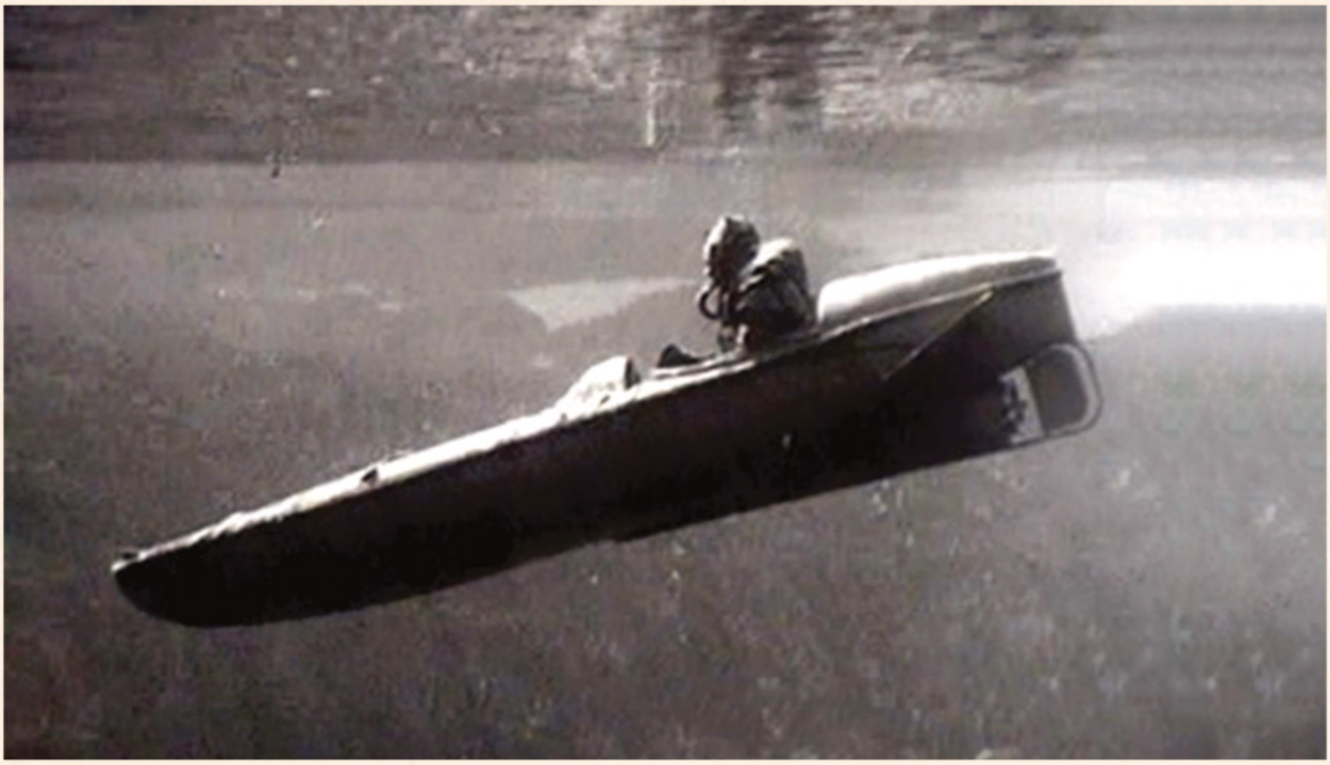


Bob Semple's New Zealand tank *was developed in fear of a Japanese invasion. The vehicle could be built over the body of an everyday tractor.*

This hand grenade *was shaped like a baseball to make it easier to throw. Unfortunately, it was prone to going off prematurely.*

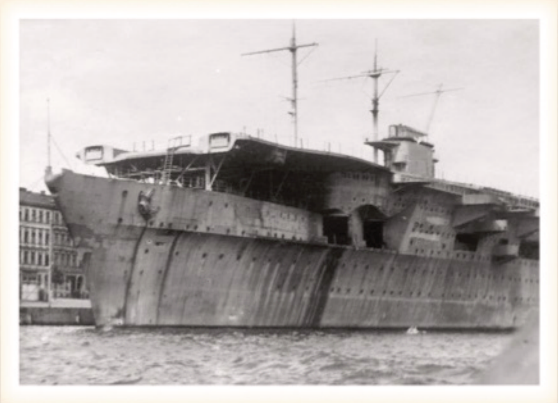


Rotating iron chains hammered into the ground *causing land mines to explode. The Sherman Crab minesweeper saw only limited use, however.*

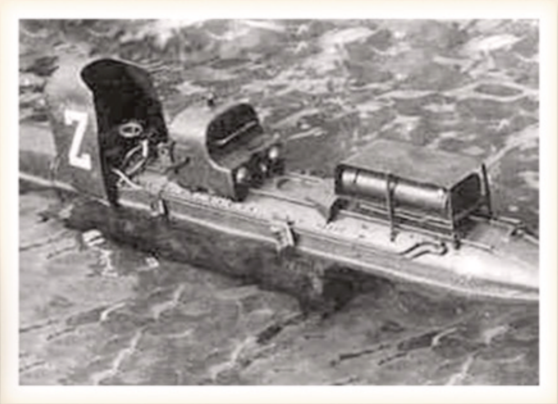


A diving canoe was designed *by the secret British organisation Special Operations Executive. The vessel was used in a few espionage cases in enemy ports and raids on docked ships. The pilot could leave the canoe and place an explosive charge on the side of a ship. The canoe was nicknamed Sleeping Beauty after SOE's chief executive Major Hugh Alleyne Reeves fell asleep in it.*

Gruppo Gamma was among the first *to pair a primitive oxygen supply with scuba diving for military purposes.*



Nazi Germany never quite got an aircraft carrier. *Graf Zeppelin was 85 percent finished when Hitler cancelled work on it due to more urgent projects.*

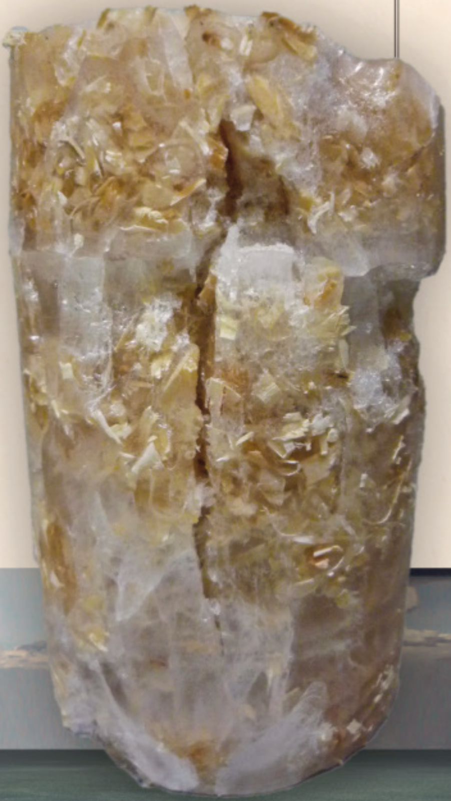


The Italian Maiale was a manned torpedo. *The new weapon was used, for example, to attack the British navy in the ports of Valetta and Alexandria (see page 40).*

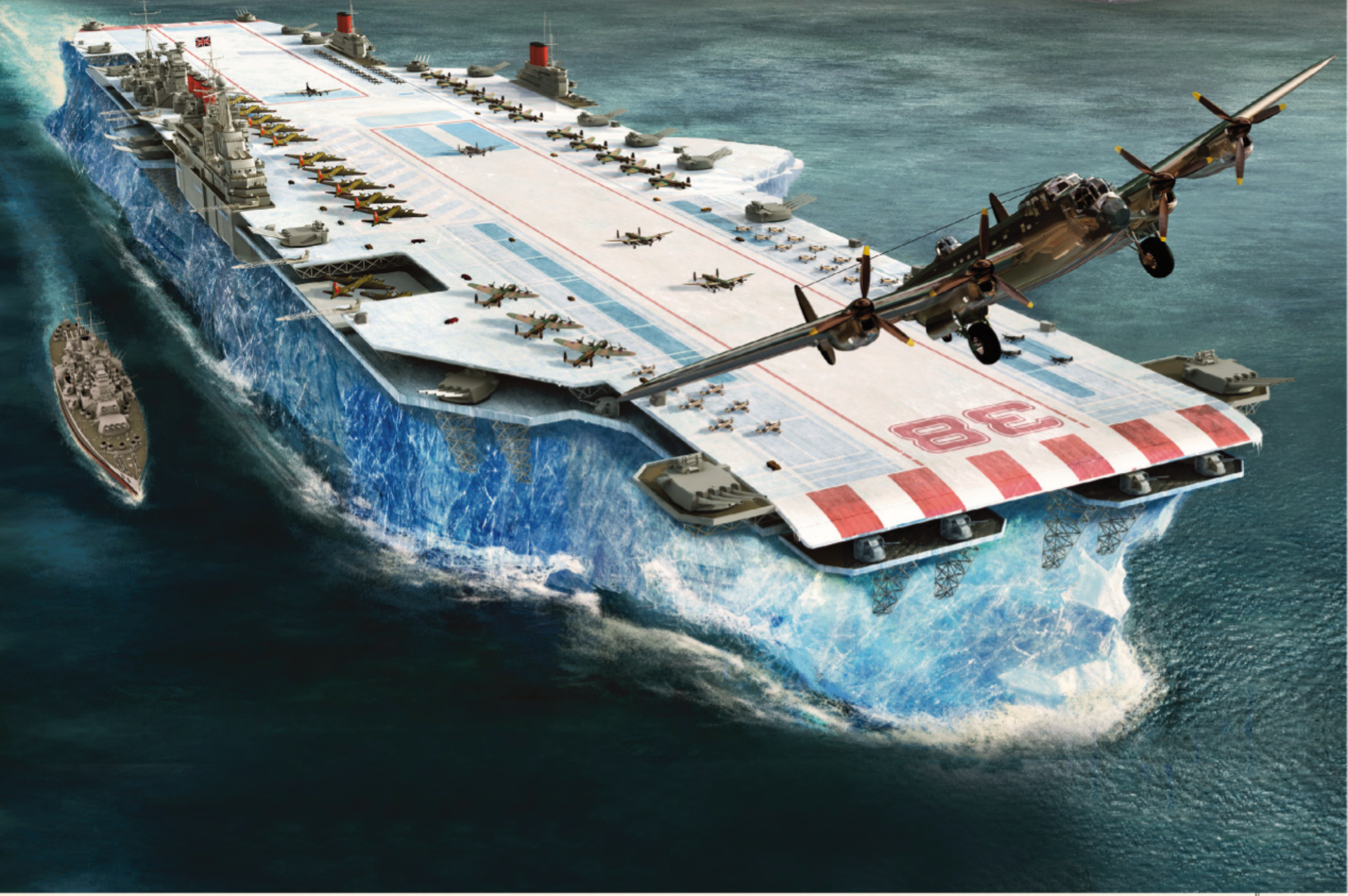
Sea mines went to extremes

Underwater attacks were an effective way to inflict damage on the enemy with a good chance of getting away unseen. In addition to regular submarines, special units in countries like Britain and Italy worked to create mini-versions of vessels that could be used for raids against enemy ships. The Italians also focussed on divers who could operate on their own under water.

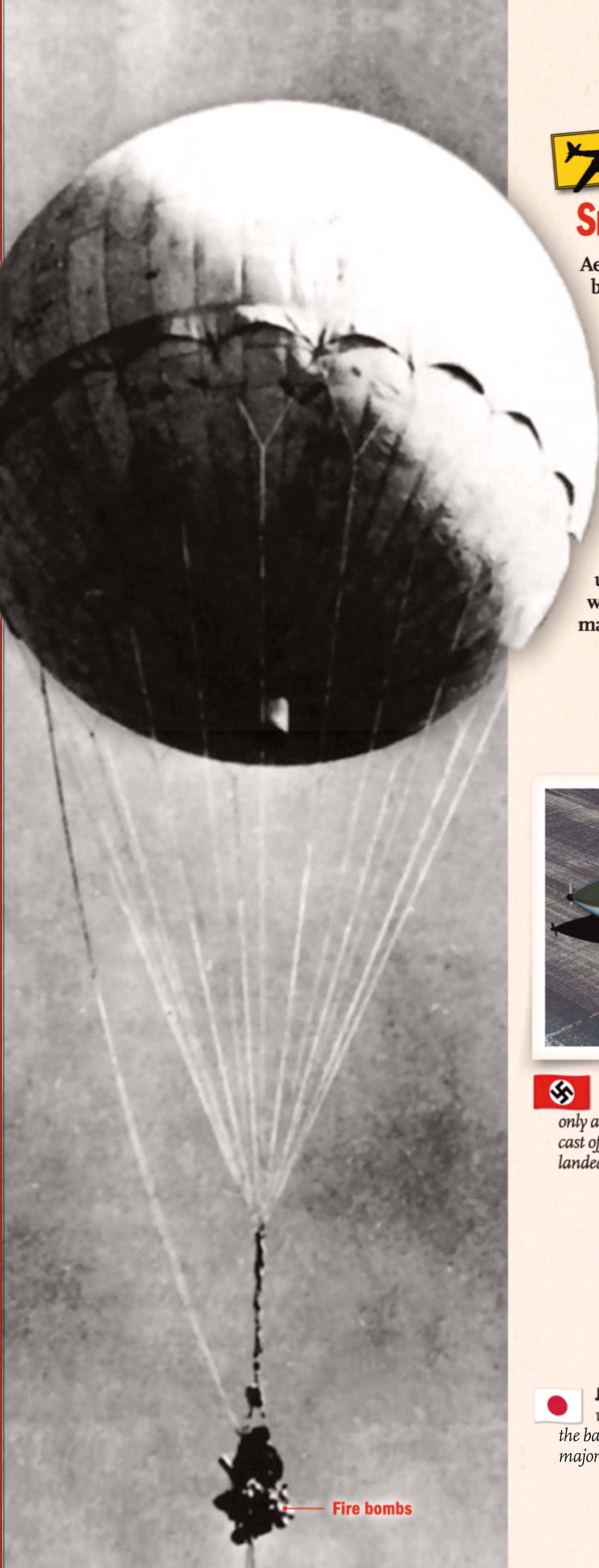
Their size meant aircraft carriers couldn't be hidden, but in turn, they were harder to sink. Germany was close to getting a super aircraft carrier ready while the British were building a floating air base using a new material: ice.



The hull of the ship *would consist of 86 percent ice and 14 percent sawdust – a strong and durable mixture.*



An ice cargo ship was proposed *by British engineer Geoffrey Pyke. Initially, the idea was to build the ship over a natural iceberg, but icebergs tend to roll and melt too fast. Instead, Pyke invented a material consisting of sawdust and ice that would be almost immune to torpedoes. Planning was far advanced, but the war ended before the ship was built.*



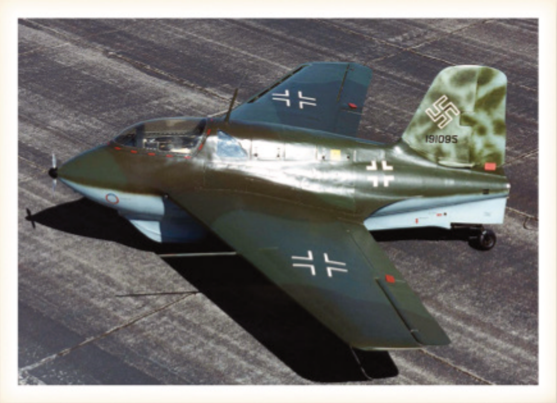
IN THE AIR

Snare attacks were planned

Aerial dominance was critical in most battlefields, but for all the airmen, the problem was reaching the enemy without exposing themselves to unnecessary danger.

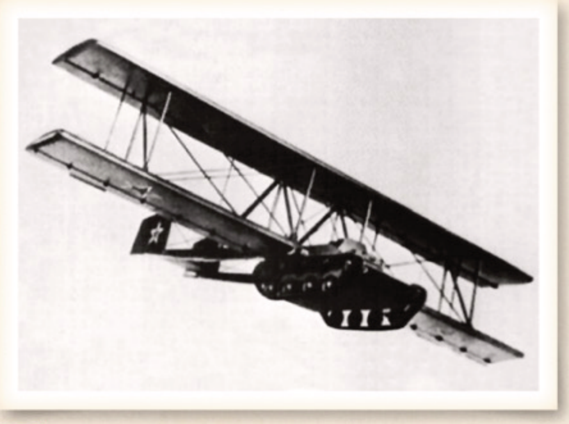
Usually, they attacked at night when planes were harder to detect – or flew low to avoid radar. But more imaginative solutions were also brought into play. For example, Americans employed animals in the US Air Force in the form of a bat bomb that was to be dropped over Japanese cities to set the highly flammable houses on fire.

New and faster planes were also under development, while the Japanese attempted to use so-called fire balloons, which would float with the jet stream across the Pacific to strike major US cities.

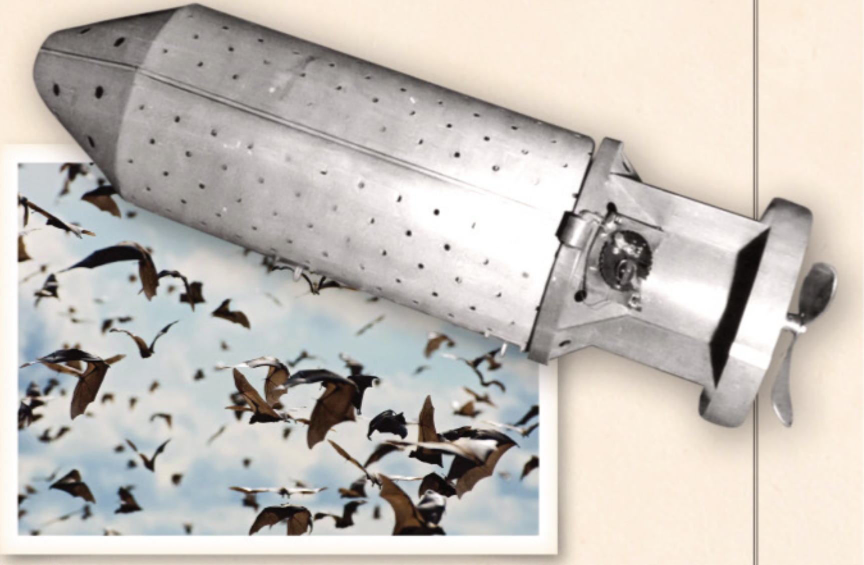


The Messerschmitt Me 163B was rocket-driven, *but flight time was only about seven minutes. The wheels were cast off after take-off, after which the plane landed on its belly.*

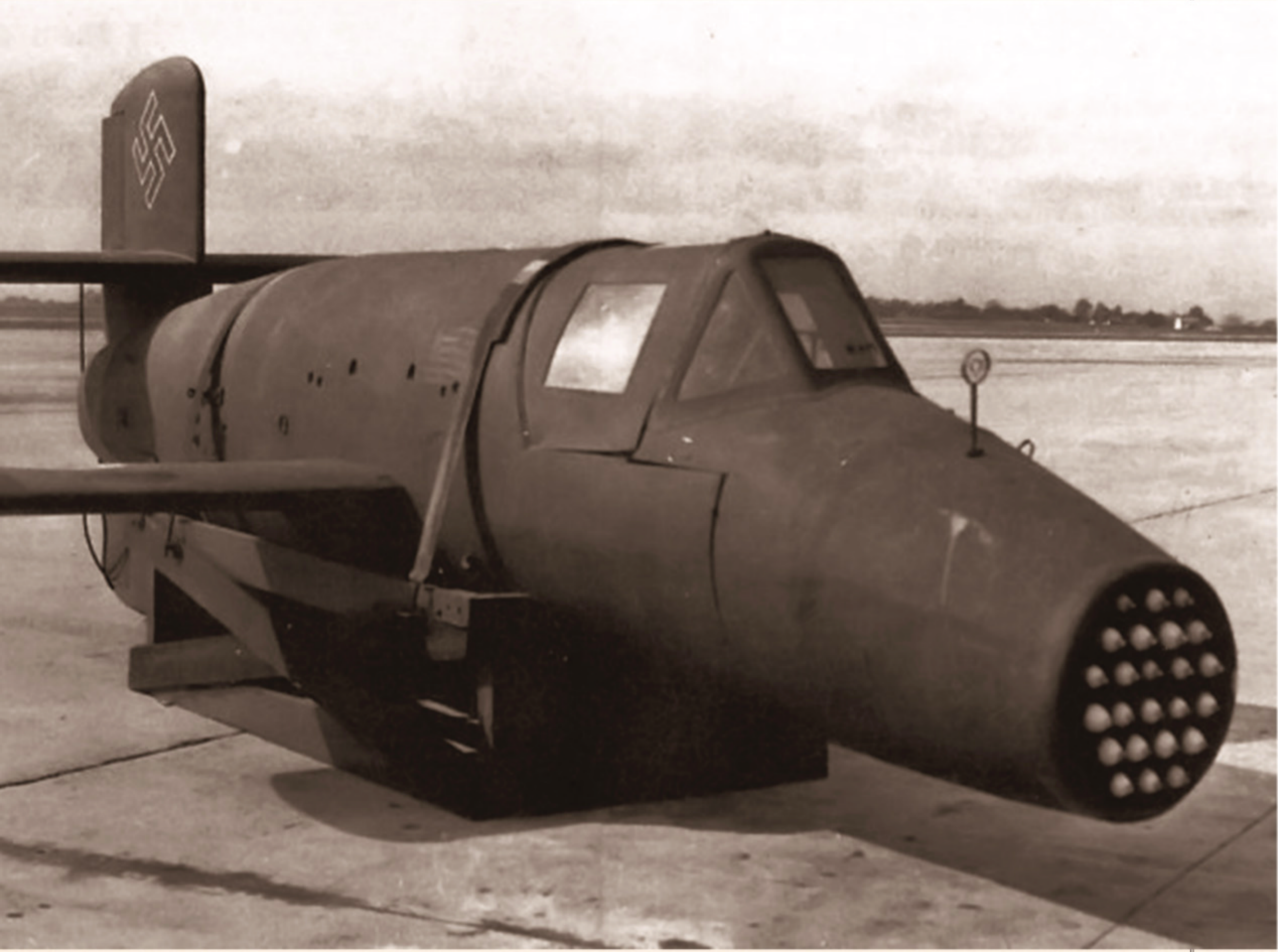
Japanese fire balloons were equipped *with fire bombs designed to explode when the balloons hit the ground. However, the vast majority landed in uninhabited areas.*



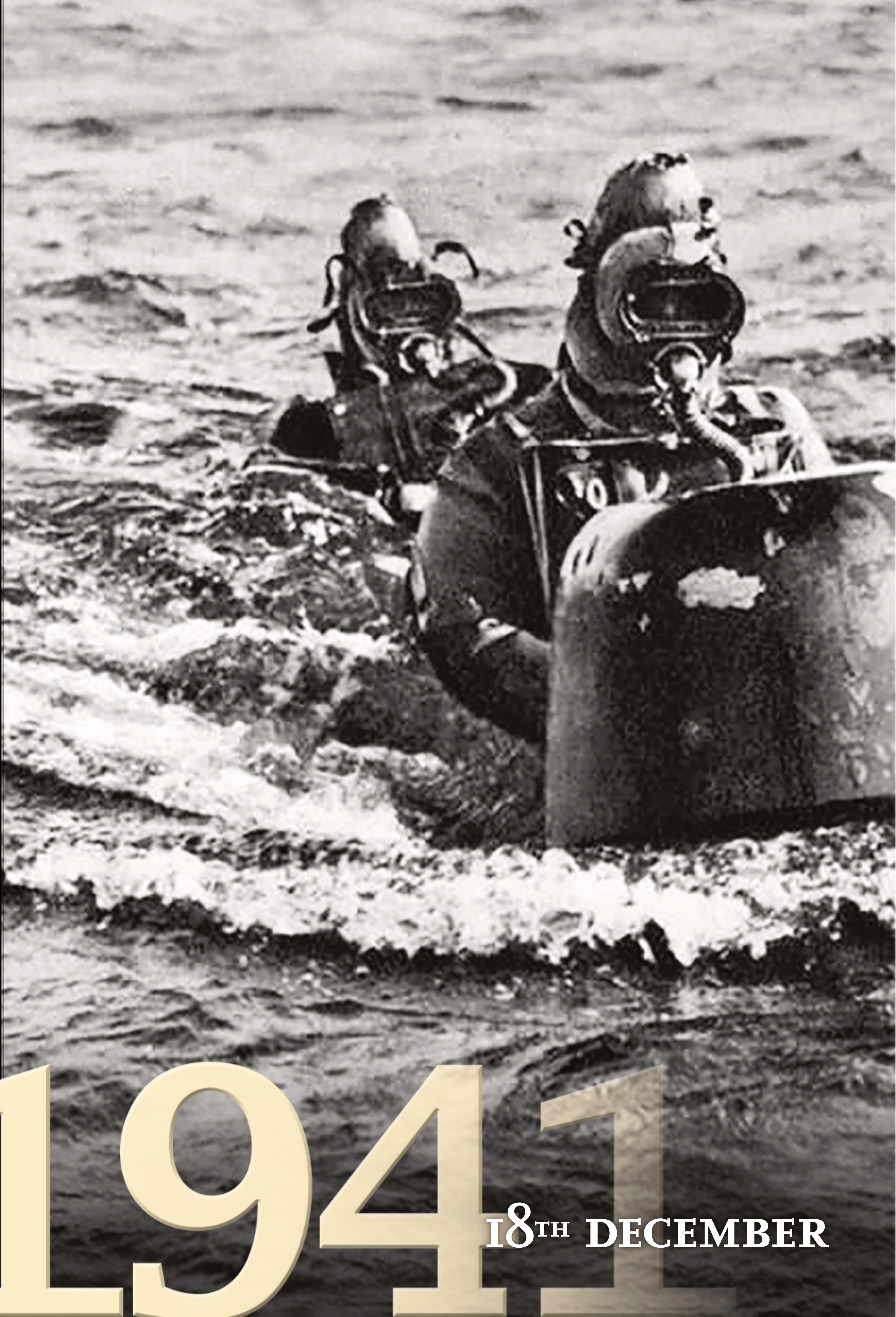
The Soviets delivered tanks to the front, *with the help of gliders. A prototype was built, but a lack of aircraft capable of towing the gliders at sufficient speed meant the project had to be abandoned.*



Hibernating bats, each with a small incendiary bomb attached, *were placed in a container and dropped over Japanese cities. This US plan went deep into development, but was overtaken by the atomic bomb.*



The Bachem Ba 349 was to be launched vertically *when Allied bombers were crossing Germany. The idea was that the pilot fired rockets at the bombers before ejecting by parachute. Also, the rear part of the hull containing the engine was fitted with parachutes, so it could be recovered and reused. The Bachem was never completed and the only manned test flight resulted in the pilot's death.*



1941

18th DECEMBER

Manned torpedoes sailed on the sea's surface before the attack, then dived down close to their target.

UNDERWATER RAID ON ALEXANDRIA

FROGMEN SNEAK INTO EGYPTIAN HARBOUR

On a dark December day three manned torpedoes speed into the port of Alexandria. Italian frogmen ride on the torpedoes, which carry a deadly cargo on board. The next morning, the frogmen are caught – and the British believe the action against the battleships in the harbour has been thwarted.

THE STAGE IS SET

Alexandria
EGYPT

Germany and Italy need supplies in the fight against the British in North Africa, but the British Mediterranean fleet is a permanent threat to the Axis' transport ships. The Italians aim to slow the British by equipping three manned torpedoes to enter the port of Alexandria and sink as many British warships as possible.

THE ITALIAN SUBMARINE *SCIRÈ* broke the sea's surface two kilometres off the Egyptian coast at Alexandria. It was just before 20.00 on 18th December, 1941. Junio Valerio Borghese, commander of *Scirè*, slowly exposed the submarine's deck. He was the brains behind Italy's impending attack on the British naval base in the Mediterranean and under no circumstances would he allow his sub to be exposed to the enemy.

Under cover of darkness from a cloudy sky and almost moonless evening, a small group of sailors climbed out of the submarine's tower onto the slippery deck where they pulled the tarpaulins from three hidden weapons: "Siluro a Lenta Corsa" (SLC or Low Speed Torpedo) manned torpedoes, which would shortly be ready for action.

Meanwhile, Borghese was in the submarine's control room and gave final orders to six frogmen, who in pairs would steer the torpedoes through the British mines into the port of Alexandria to blow up the largest of the British ships. Following his orders, the frogmen scaled one by one up the tower's metal ladder to take to the water on the "Maiale" (Italian for pig) that the divers liked to call the unwieldy torpedoes.

Alexandria's port is one of the world's oldest. The earliest harbour facilities were built around 1900 BC and the harbour has been a lively hub since antiquity.

The machines only emitted a faint sound when the engines were started, but their momentum was precisely enough to keep the crew's heads above the surface of the Mediterranean while the Maiale's body remained below it. At 21.00, the frogmen's leader – Luigi Durand de la Penne – gave the OK signal with his hand, and the three manned torpedoes moved slowly away from *Scirè*.

Back on the submarine's deck, Borghese proudly watched the men who quickly disappeared into the dark. The commander could do no more. Now it was up to the specially trained elite soldiers on the torpedoes to carry out the underwater attack that the commander hoped would be one of the war's most spectacular.

SPECIAL FORCES WOULD WIN IN THE MED

The struggle for the Mediterranean broke out in 1940 when Italian leader Benito Mussolini joined Germany's fight against Britain and France, subsequently launching a failed campaign against the British in North Africa. The Nazis immediately came to the aid of their Italian allies, and suddenly the desert was one of the war's hotspots.

The Italian frogmen practised intensively up to the mission to get used to heavy diving equipment.

Italian frogmen switched sides in 1943

After the mission the divers were taken prisoner. But once Mussolini was deposed, the Italians were on the side of their guards.

The six Italians were sent to a prison camp in Palestine after the raid against Alexandria. Later, they were moved to camps in India and South Africa.

But in the summer of 1943, Mussolini was deposed as government leader in Italy, and the country joined the Allies. The captured frogmen were now on the Allied side and were released. Several of the divers chose to follow Italy's new government and fought with the British against the Nazis.

Warships could be outfitted and repaired in peace in Alexandria, which was seen as a safe haven.

Alexandria's harbour was one of the Royal Navy's main strongholds.

The Desert War meant that troops and supplies needed to be transported across the Mediterranean from Europe to North Africa. The Italian fleet included six large battleships, which effectively protected the Axis transport convoys. But British air strikes hit the half the battleships in late 1940. The Axis responded again with an attack on the British Royal Navy. In November, German U-boats sunk a British aircraft carrier and a battleship. Cumulative losses had left the British with just two large battleships in the Mediterranean in 1941: *HMS Valiant* and *HMS Queen Elizabeth*, both of which were based in Alexandria. If the ships were put out of play, the most serious threat to the Axis convoys would be removed.

The Italian fleet held a trump card for this task: the special force La Decima Flottiglia MAS. The unit with the motto "Memento audere semper" – Remember to always dare – was an elite force with divers who had the task of sneaking into enemy bases in small motor vessels to destroy ships and other equipment. One of the vessels was a manned torpedo, which after some technical problems had finally proved successful in the summer of 1941, when six frogmen sank three ships in the port of Gibraltar. Decima MAS leader, Junio Borghese, was given the job of planning the ambitious attack on the British base in Alexandria.

ITALIAN WROTE FAREWELL TO HIS MOTHER

With the aid of the fleet's meteorologists, Borghese chose a day of attack with both a new moon and clouds. At the same time, he received reports from reconnaissance aircraft that the main targets, *Valiant* and *Queen Elizabeth*, were still in Alexandria. If an aircraft carrier was also in the port, that would become the third target – otherwise the divers would go for a tanker that could set the sea ablaze in the harbour.

The Italians were well-prepared, but there was still a lot that could go wrong. The manned torpedoes were hard to handle, and even a small mistake could put the vessels off course, so the enemy would discover the torpedoes. Everyone in Decima MAS was aware that the mission would be

NAME **JUNIO VALERIO BORGHESE**

TITLE COMMANDER

1906-1974

Officer was an unapologetic fascist

The head of the operation in Alexandria was Junio Valerio Borghese. The commander was on board the submarine *Scirè* and did not actively participate in the attack.

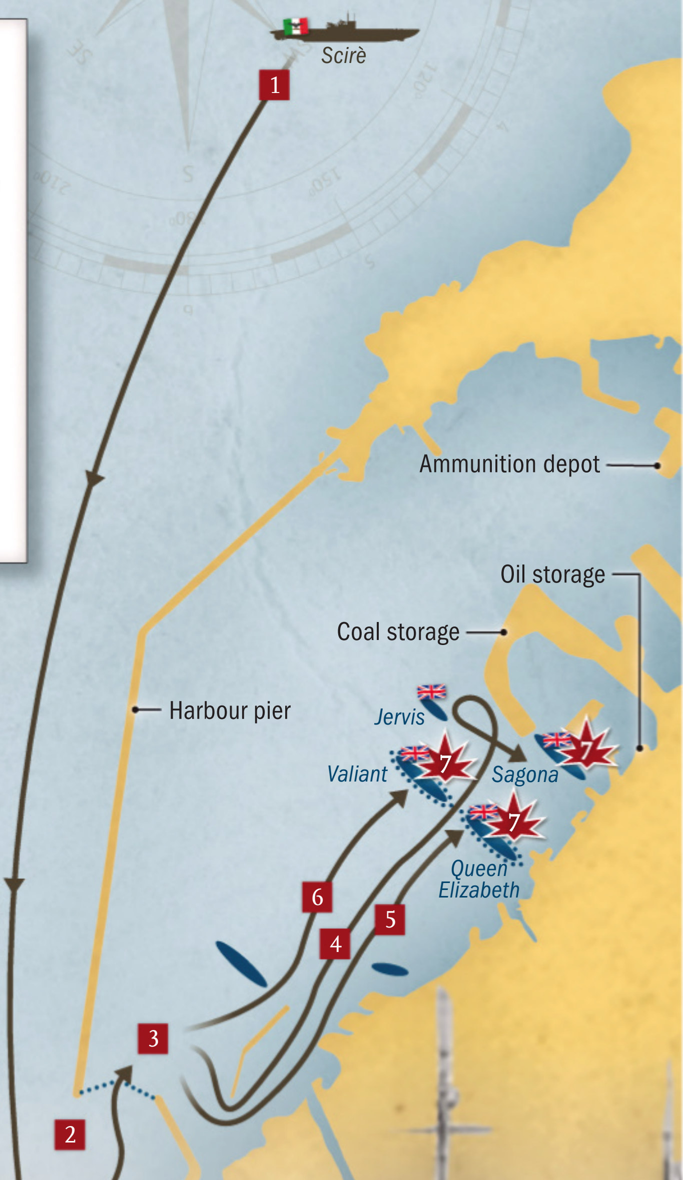
When Italy crossed to the Allied side, Borghese continued the struggle for fascism with Mussolini in the Republic of Salò in Northern Italy.

After the war, the officer, who was born into the Italian aristocracy, was involved in new fascist movements and an unsuccessful coup in 1970.

- **Was nicknamed The Black Prince.**
- **Lived in his final years in Franco's Spain.**

Mission was a race against time

The operation begins at 21.00, giving the frogmen nine hours of darkness to get through a minefield, circumvent a barrier at the harbour entrance and place the limpet mines. Before the mission, the Italians have no idea how difficult the task will be.



1 Submarine drops the men near the harbour

Italian submarine *Scirè* sails close to the port of Alexandria, so the three-manned torpedoes' batteries have enough power to reach their targets. At 21.00 on 18th December, the team leap into action.

Scirè was custom-built to carry manned torpedoes and participated in several raids in the Mediterranean before it was sunk in 1942.

2 The harbour is blocked

When the frogmen reach the harbour entrance, the first officer discovers the protective net is well constructed and difficult to break through.

3 The boom is opened

The Italians are in luck as three British ships arrive and the net is opened at 02.42. The divers take advantage of the opportunity to sneak in unnoticed.

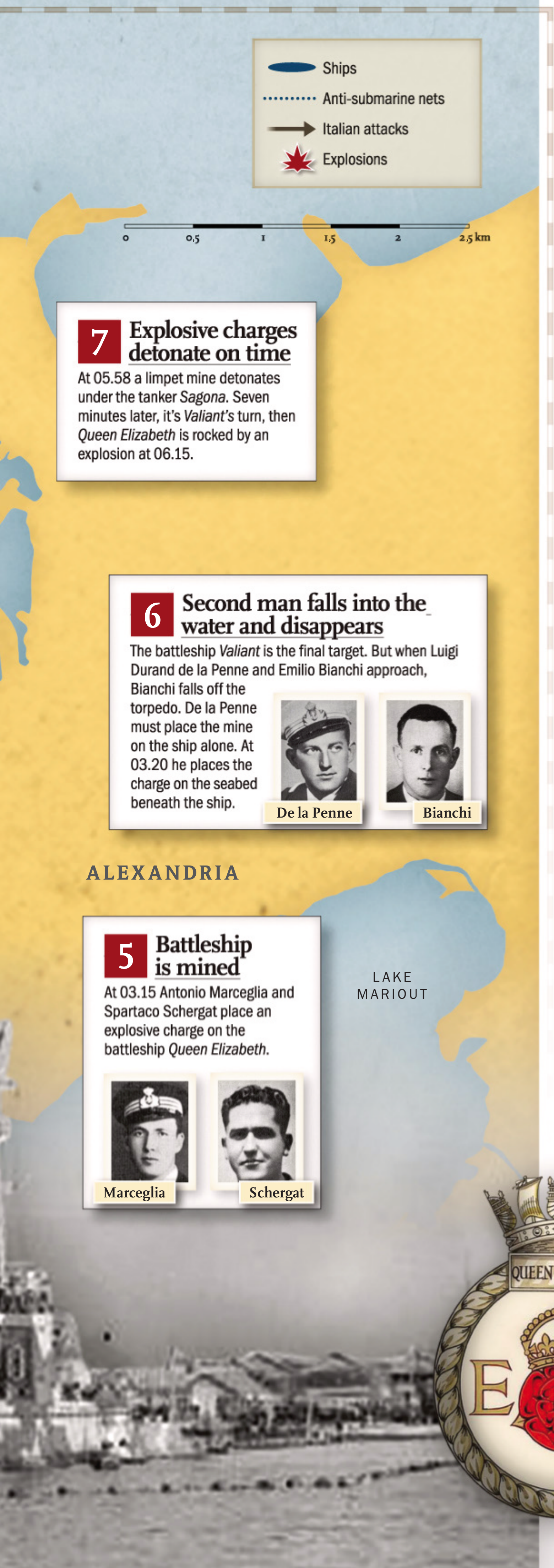
4 Tanker is targeted to set sea ablaze

Vincenzo Martellotta and Mario Marino choose the tanker *Sagona* as a target and at 02.55 place explosives and fire bombs around the hull. The Italians hope that burning oil from the tanker will flow out and transform the harbour into a raging inferno.

Martellotta

Marino

Protective anti-submarine barriers in the form of a mesh net were placed around Queen Elizabeth.



7 Explosive charges detonate on time

At 05.58 a limpet mine detonates under the tanker *Sagona*. Seven minutes later, it's *Valiant's* turn, then *Queen Elizabeth* is rocked by an explosion at 06.15.

6 Second man falls into the water and disappears

The battleship *Valiant* is the final target. But when Luigi Durand de la Penne and Emilio Bianchi approach, Bianchi falls off the torpedo. De la Penne must place the mine on the ship alone. At 03.20 he places the charge on the seabed beneath the ship.

5 Battleship is mined

At 03.15 Antonio Marceglia and Spartaco Schergat place an explosive charge on the battleship *Queen Elizabeth*.

both demanding and dangerous. Before departure, unit leader Luigi Durand de la Penne wrote a farewell letter to his mother, which began with the words:

"My Dear Mother: By the time you receive this letter I will be dead. I volunteered for a dangerous mission which failed..." Nevertheless, 27-year-old de la Penne felt safe on the torpedo on 18th December, 1941 as it moved slowly through the Mediterranean's icy waters outside the port of Alexandria.

The athletic lieutenant commander was the most experienced in the group whose previous missions had included being part of the team that had sunk three British ships at Gibraltar three months previously. At that time, his unit fled after the mission through neutral Spain and returned to Italy. But de la Penne knew that it would be more difficult for the men to escape this time. The vessels had no opportunity to return to *Scirè*, so the divers would be left to fend for themselves after the raid. Their scant knowledge of English meant the Italians would struggle to avoid drawing attention to themselves in Egypt, where the police worked closely with the British.

FROGMEN TOOK AMPHETAMINES FOR ENERGY

Behind de la Penne sat Sergeant Emilio Bianchi, whose head was slightly closer to the surface than his commander due to the force of the rear propeller, which pushed the vessel upwards. Both were, however, fine and able to breathe normally, so the men could preserve the oxygen in the bottles they were carrying. In the evening darkness on the high seas, the risk of being detected by the Coast Guard was minimal. Nevertheless, they were ready to dive if a patrol boat approached. As a further precaution, the three torpedoes sailed a good distance apart and only came together again outside the port. The minefield was no hindrance to the small and slow vessels as they worked their way into the harbour.

Once they rendezvoused, the frogmen dug out bags filled with provisions and while the engines ticked over, the men hurried to eat a little. The bags also contained amphetamine pills, which sent energy surging around their body before the night's hardships.

The next obstacle was a strong metal anti-submarine boom, which was stretched out along the harbour entrance to prevent attacks. The barrier was harder to climb than expected. Even though the frogmen were trained to raise the metal net with lifting gear in the toolboxes at the back of each Maiale, everyone was worried that the work would make so much noise that the unit would be revealed.

SABOTEURS ENTERED HARBOUR AT FULL THROTTLE

While the Italians planned how best to handle the task, the lights in the harbour and along the pier suddenly turned on, and the lighthouse only 500 metres away began to blink. The Decima MAS force quickly spotted the reason out to sea: three British destroyers returning from »

The Queen Elizabeth was severely damaged in the attack and repairs took over a year.

fighting near the Libyan city Sirte shot through the waves. The boom was slowly opened so that the warships could pass.

"Let's get away", de la Penne whispered and signalled to his colleagues that everyone should dive down. At the same time, a patrol boat came through the barrier's opening and began to drop small depth charges in the area outside the pier. The bombs rolled out from the back of the boat and exploded a few metres below the surface of the water to hit any enemy that might be lurking in the deep. Instead of sailing into the port immediately, the frogmen had to wait and try to follow once the big ships arrived. Once submerged the Italians felt the pressure from the depth charges as they detonated. The explosions were so close that the force pushed the men's legs hard against the metal body of the torpedo and almost caused the small vessels to capsize.

> **29 gold medals**
> **for courage were awarded to the Decima MAS frogmen. The unit sank or damaged a large number of Allied ships in the Mediterranean.**

When the destroyers approached, the patrol boat disappeared, and the frogmen speeded up to the maximum in an attempt to follow the ships. Everybody came through, but the danger was not yet over. When Vincenzo Martellotta rose to the surface with his second man Mario Marino, the pair found themselves just behind the first destroyer. The ship's propeller created turbulence in the water that made it difficult for the torpedoes to keep pace. From behind, the men saw how the next destroyer was coming closer and closer with its course heading towards them. Martellotta and Marino saved themselves at the last minute by forcing the Maiale to one side, away from the destroyer.

De la Penne and Bianchi also flirted with death as the pair lay under the hull of the other destroyer. As the ship pulled away from the two divers, a pressure wave pushed the vessel all the way down to the seabed. But a few seconds later, the third destroyer passed, and this time the forces were opposed and flung the torpedo upwards. De la Penne was unable to manoeuvre the vessel, which crashed into the metal edge on the barrier net before he regained control. At a glance, the torpedo was undamaged and slipped through the barrier. Thanks to the noise from the ship engines, the guards at the pier had heard nothing untoward. Meanwhile the final team of Antonio Marceglia and Spartaco Schergat had also got through unscathed.

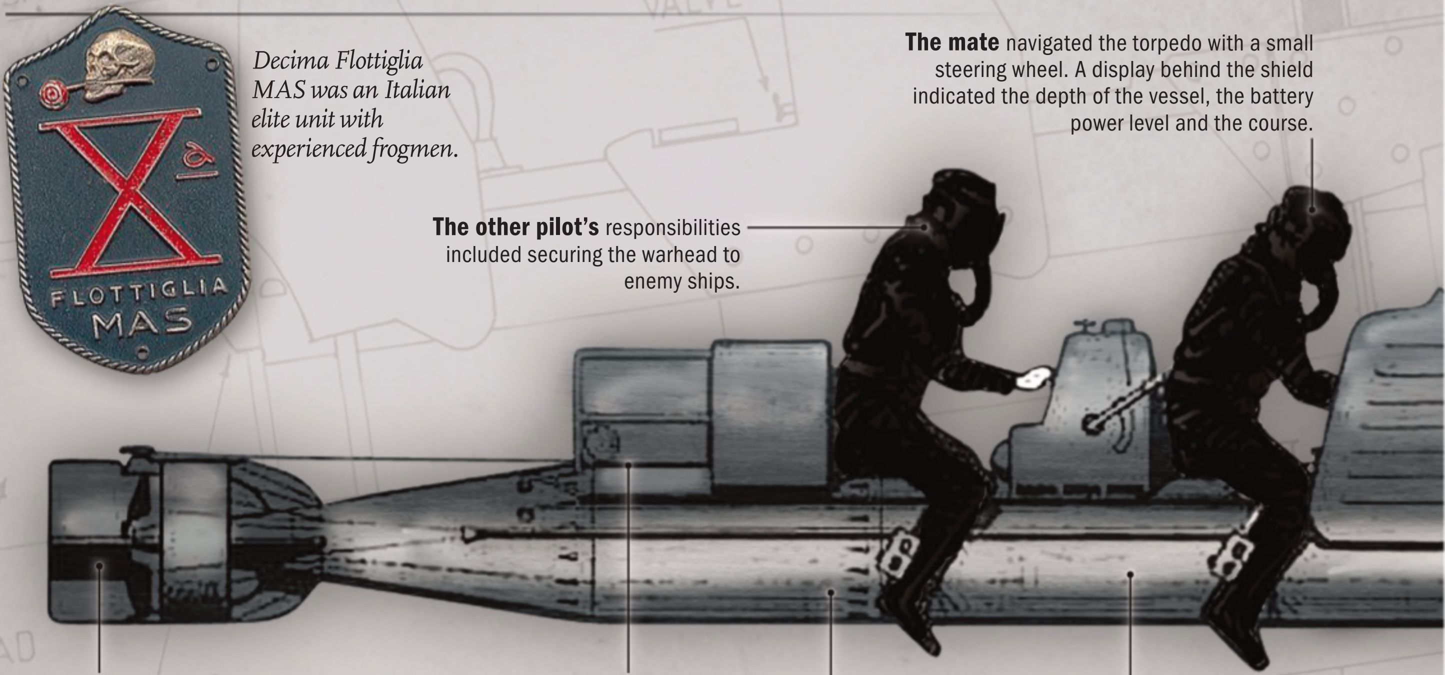
Dive suit was destroyed

Inside the harbour de la Penne directed his manned torpedo towards its target, *Valiant,* which lay farther in the harbour To the Italians' annoyance, the battleship was protected by a torpedo net. Instead of diving down to try lifting the net from the seabed, they rose to the surface, pushing the 53-centimetre-

WEAPON

Torpedoes were ungainly

Italy's secret weapon was a brilliant idea, but not quite so brilliantly constructed. The vessels sailed slowly and were difficult to control.



Decima Flottiglia MAS was an Italian elite unit with experienced frogmen.

The mate navigated the torpedo with a small steering wheel. A display behind the shield indicated the depth of the vessel, the battery power level and the course.

The other pilot's responsibilities included securing the warhead to enemy ships.

The rudder was behind the propeller. It was controlled by a wire from the mate's steering wheel.

The toolbox contained equipment that was used to remove the warhead from the torpedo.

The electric engine was weak, providing only 1.6 horsepower.

The battery delivered enough energy for a range of 15 kilometres.

wide Maiale through two buoys that formed a focal point. The manoeuvre created a crackling sound that wasn't heard on the ship, but de la Penne noticed immediately that he had a tear in his diving suit where the cold water could get in. At the same time, the Maiale's propeller had got caught in a wire, and the torpedo plummeted 14 metres down to the bottom of the harbour. When de la Penne turned around, he saw that Bianchi had disappeared!

Meanwhile, Martellotta and Marino scooted around the harbour looking for a suitable target. Unlike their comrades, the pair remained on the water's surface to remain oriented. But no aircraft carriers were based in Alexandria, so the men opted to approach a large Norwegian tanker – *Sagona* – that was anchored in the harbour.

As the Italian pair prepared to remove their detachable warhead – a limpet mine – from the front of the torpedo, Martellotta was struck in the head by the rudder of a boat sailing over the Italians. The strike caused the frogman to vomit, and he only just managed to remove his oxygen tube before the sick hit the water. Martellotta could no longer stay underwater, so Marino had to complete the disassembly alone while his partner swam to the surface.

The mine had to be tied to *Sagona* with a wire. To cause the greatest possible damage, the bomb should be placed in the middle of the ship's keel, but the task required two men. On his own, Marino had to settle for attaching the mine to the ship's stern. At 02.55, Marino set the timer to detonate three hours later. Then he placed a number of incendiary bombs around the *Sagona,* which would set fire to the oil as it seeped from the broken hull and spread to the rest of the harbour.

When the task was completed, Marino set the Maiale to self-destruct and ascended to join Martellotta. Together, the frogmen swam to a deserted place in the harbour.

The mission was easier for Marceglia and Schergat. Just like de la Penne and Bianchi, the pair had to break a torpedo net to get close to their target, *HMS Queen Elizabeth*. The two frogmen pulled a wire under the battleship mid hull, and then attached their mine using hinges. By 03.15, the limpet mine dangled one metre from the ship's hull. Marceglia set the timer and rushed to get away. The Italians surfaced with a splash and the sound caused a port guard to shine a spotlight on the water. But the guard did not spot the heads above the dark water's surface. The frogmen headed towards the coast, set their torpedo to self-destruct and swam the last stretch underwater to reach land.

De la Penne had to swallow salt water

For de la Penne, the situation was critical: his torpedo was smashed and his partner had vanished. 14 metres down on the seabed everything was cold, dark and quiet. Bianchi had swam to the surface, but couldn't spot his comrade.

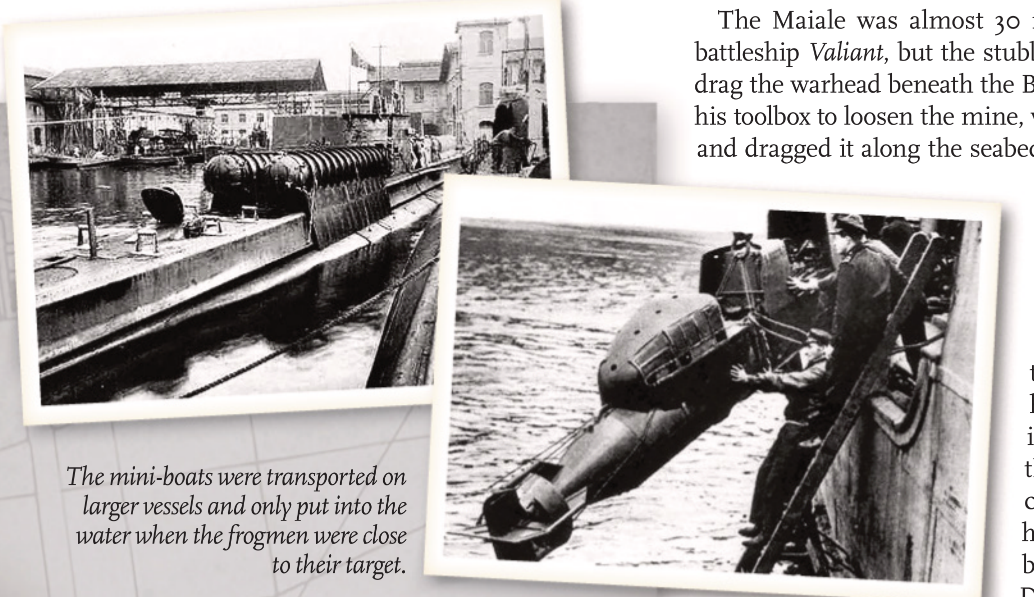
The Maiale was almost 30 metres from its target, the battleship *Valiant*, but the stubborn de la Penne decided to drag the warhead beneath the British ship. The Italian used his toolbox to loosen the mine, which weighed over 200 kg, and dragged it along the seabed centimetres at a time. The seabed was slippery, which made it difficult for the diver to get a foothold, but on the other hand the warhead slid easily through the mud.

De la Penne had to stop time and time again to regain his strength. His body boiled inside his diving suit despite the trickle of cold water coming in through its torn hole. At the same time water began to seep into his mask. De la Penne forced himself to swallow sea water to avoid drowning, even though the salt ripped at his throat.

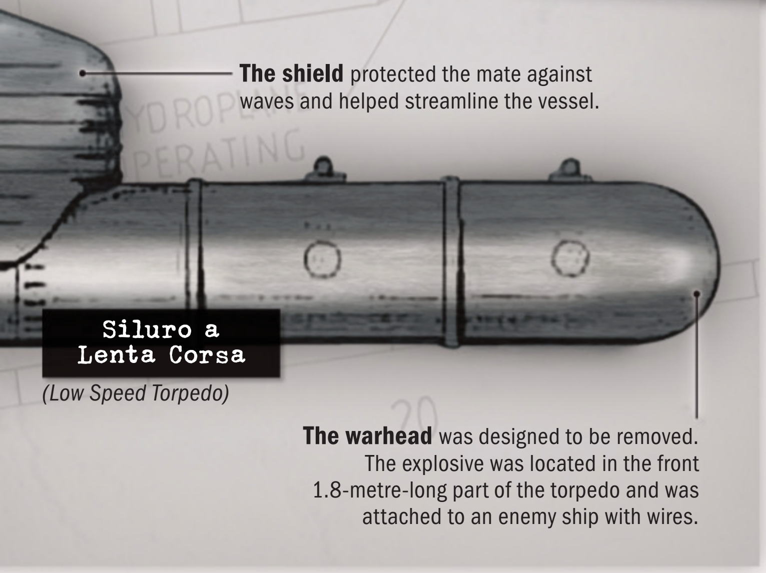
The Italian had difficulty orienting himself in the darkness of the seabed – as he towed the warhead, he churned up the seabed beneath him. But suddenly he caught sight of *Valiant's* keel, and after 20 long minutes he finally reached the ship. The lieutenant commander set the timer, five metres beneath its target. Although the location of the explosive charge was far from optimal, the explosion could still seriously damage the battleship. De la Penne pulled off his oxygen mask and swam to the surface and away from *Valiant*.

"Stop!" came a sudden command from the ship.

De la Penne continued to doggedly swim away, but moments later bullets smashed into the war next to the Italian. De la Penne took cover behind a buoy, where to



The mini-boats were transported on larger vessels and only put into the water when the frogmen were close to their target.



The shield protected the mate against waves and helped streamline the vessel.

The warhead was designed to be removed. The explosive was located in the front 1.8-metre-long part of the torpedo and was attached to an enemy ship with wires.

his delight he found his companion Bianchi. But as bullets continued to rip through the water, the men had to surrender.

Italians were held in bottom of ship

On board *Valiant* de la Penne and Bianchi were immediately questioned. But the Italians were well-prepared and revealed nothing but their name and rank, although the British, using an Italian-speaking officer, were sure that the prisoners understood the questions. Convinced that an attack had been averted in time, the officers gave up trying to get anything from the frogmen.

Luigi de la Penne breathed a sigh of relief. But concern grew rapidly again as a couple of soldiers led him and Bianchi deeper into the ship. At the bottom of the ship, the prisoners were taken to the storehouse, where they were given cigarettes and a glass of rum.

Neither could relax. The Italians were locked in a few metres above the place where de la Penne had just armed the limpet mine, which was set to detonate slightly after 06.00.

The minutes ticked away while de la Penne paced nervously back and forth in his cell. At the same time, he scrutinised his waterproof watch: 05.20, 05.30, 05.40...

At 05.50 de la Penne could delay no longer and asked to speak to the ship's captain, Charles Morgan immediately. De la Penne told Captain Morgan that his ship would be sinking shortly, but refused to give any further information.

A silent de la Penne was taken back to his cell. Over the speakers he could hear a voice calling all crew members on *Valiant* to the deck. The first sailors had already reached the deck when a colossal explosion rolled through the naval harbour at 05.58. One kilometre away, the back of the tanker *Sagona* was in flames, while the explosion had also set light to the nearby destroyer *Jervis* and thrown her crew to the deck.

Unfortunately for the Italians, the mine that Marino failed to lay directly under the *Sagona* had only ripped a hole in the back of the ship, so the oil tanks in the middle were virtually undamaged. The ship burned, but the plan to ignite the rest of the harbour came to nothing.

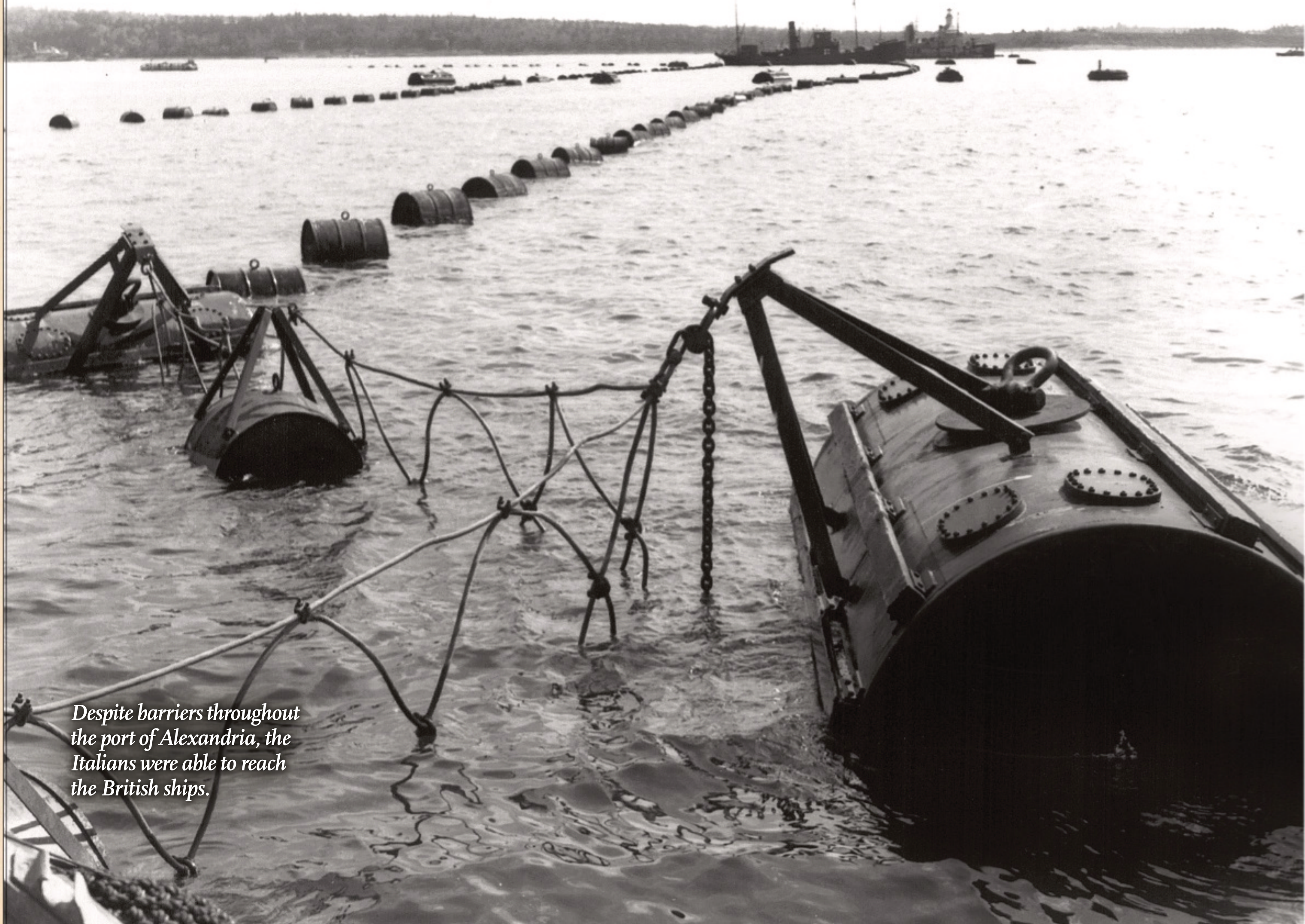
{ *Valiant* and *Queen Elizabeth* belonged to the same class of battleship. *Queen Elizabeth* was launched in 1913 and *Valiant* in 1914. Both ships fought in WWI.

Ships were torn apart

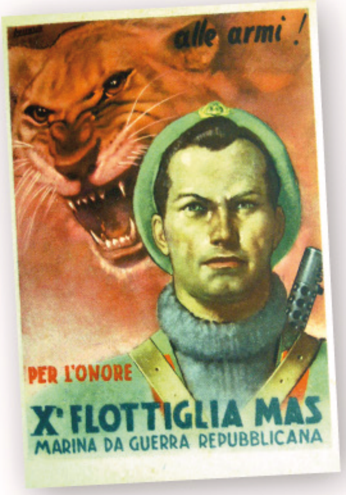
The *Valiant's* crew were shocked by the situation on the affected ships when suddenly they were thrown across their own deck. At 06.05 the explosion from de la Penne's warhead blew several holes in the hull. 30 metres of the warship's 200-metre-long underside was damaged in the explosion.

The Italians at the bottom of the ship felt the shaking most violently of all. The blast threw de la Penne with such great force that he briefly lost consciousness. When the frogman came around, door of the room was in flames, and the Italian limped his way through dense smoke at the bottom of the ship to reached fresh air on deck, where confusion reigned.

After a few minutes, the Italians' final explosive shattered the 31,000-tonne heavy battleship *Queen Elizabeth*, blasting away the bottom of the ship. Water poured in through a long gash, and metal pieces from the engine rooms shot through



Despite barriers throughout the port of Alexandria, the Italians were able to reach the British ships.



Decima Flottiglia MAS existed until Italy's surrender in September 1943.

the ship's funnels. Soon the air was also filled with ash that burst out of every crack on the broken British vessel.

Even though the sailors on *Queen Elizabeth* like those on *Valiant* were on deck, the heavy explosion killed eight Britons.

Valiant's damage was not as extensive as the explosive had been laid on the seabed and not stuck to the hull. For the same reason, both Bianchi and de la Penne survived. When the British rallied themselves, both de la Penne and Bianchi were arrested and taken to the quay.

In the clear morning light, the Italians were pleased with how their targets had been sunk. The harbour's low depth meant, however, that some of the hulls were still above water, meaning the vessels could probably be salvaged and later repaired. But there was no doubt that the mission had been successful. Decima MAS had inflicted a wound on the enemy that would take a long time to heal.

Churchill was envious

On land, de la Penne and Bianchi were reunited with Martellotta and Marino, who had also been arrested during the night. After placing the explosive under *Sagona*, the pair had gone unnoticed from the water and shed their diving suits, putting on plain clothes. However, in attempting to escape the guarded port area, they had been exposed and captured.

They had been luckier than Marceglia and Schergat. Unseen, the pair had reached the shore along the most guarded coastline. Posing as French sailors, they'd successfully made their escape, but had made one critical error: the frogmen had arranged to have only British pounds in their pocket. They had to switch to Egyptian currency in order to pay a local fisherman to sail them to a secret destination, where the Italian submarine *Zaffiro* would pick them up. But while Marceglia and Schergat exchanged money, a pair of Egyptian police officers grew suspicious and arrested the Italians before handing them over to the British.

After two days, the crew on the *Zaffiro* had given up any hope of seeing any of the six Decima MAS heroes and sailed away from enemy waters. At home in Italy the fleet took the loss of the frogmen quietly. The price of success had been relatively low.

After the attack in Alexandria, the British had no large warships in the Mediterranean, which was once again Italy's Mare Nostrum – "our sea". Over the following six months, the Axis could bring troops and equipment to North Africa unchecked.

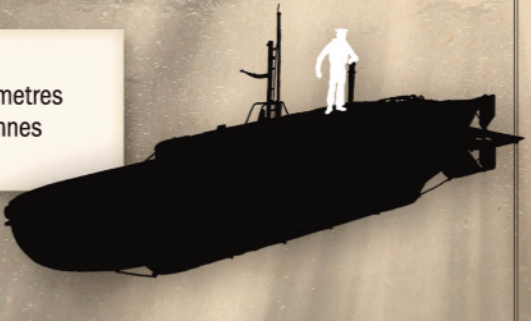
Following the attack in Alexandria, British Prime Minister Winston Churchill wrote to his military chief adviser:

"Is there any reason why we should be incapable of the same kind of scientific aggressive action that the Italians have shown? One would have thought that we should have been in the lead".

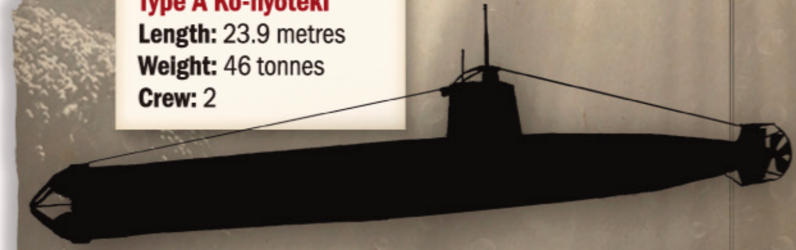
Midget subs caught enemy by surprise

Inspired by the Italians, several nations developed midget submarines and manned torpedoes that could penetrate heavily guarded ports.

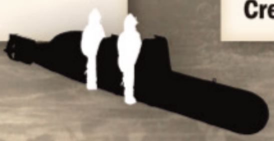
X-Class
Length: 15.6 metres
Weight: 27 tonnes
Crew: 4



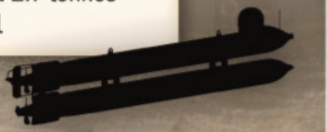
Type A Ko-hyoteki
Length: 23.9 metres
Weight: 46 tonnes
Crew: 2

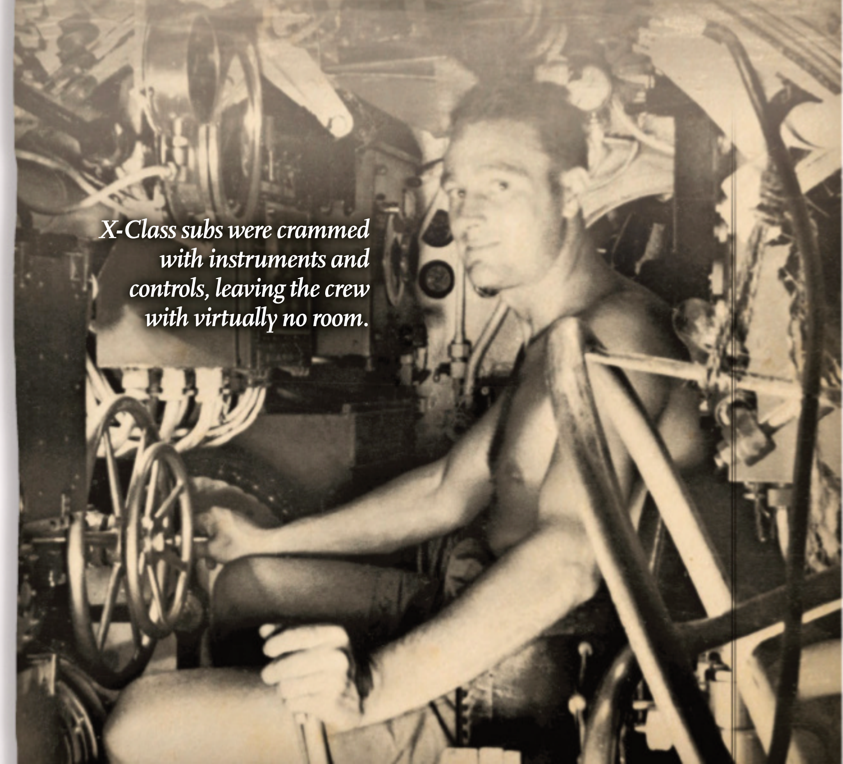


Chariot
Length: 6.8 metres
Weight: 1.6 tonnes
Crew: 2

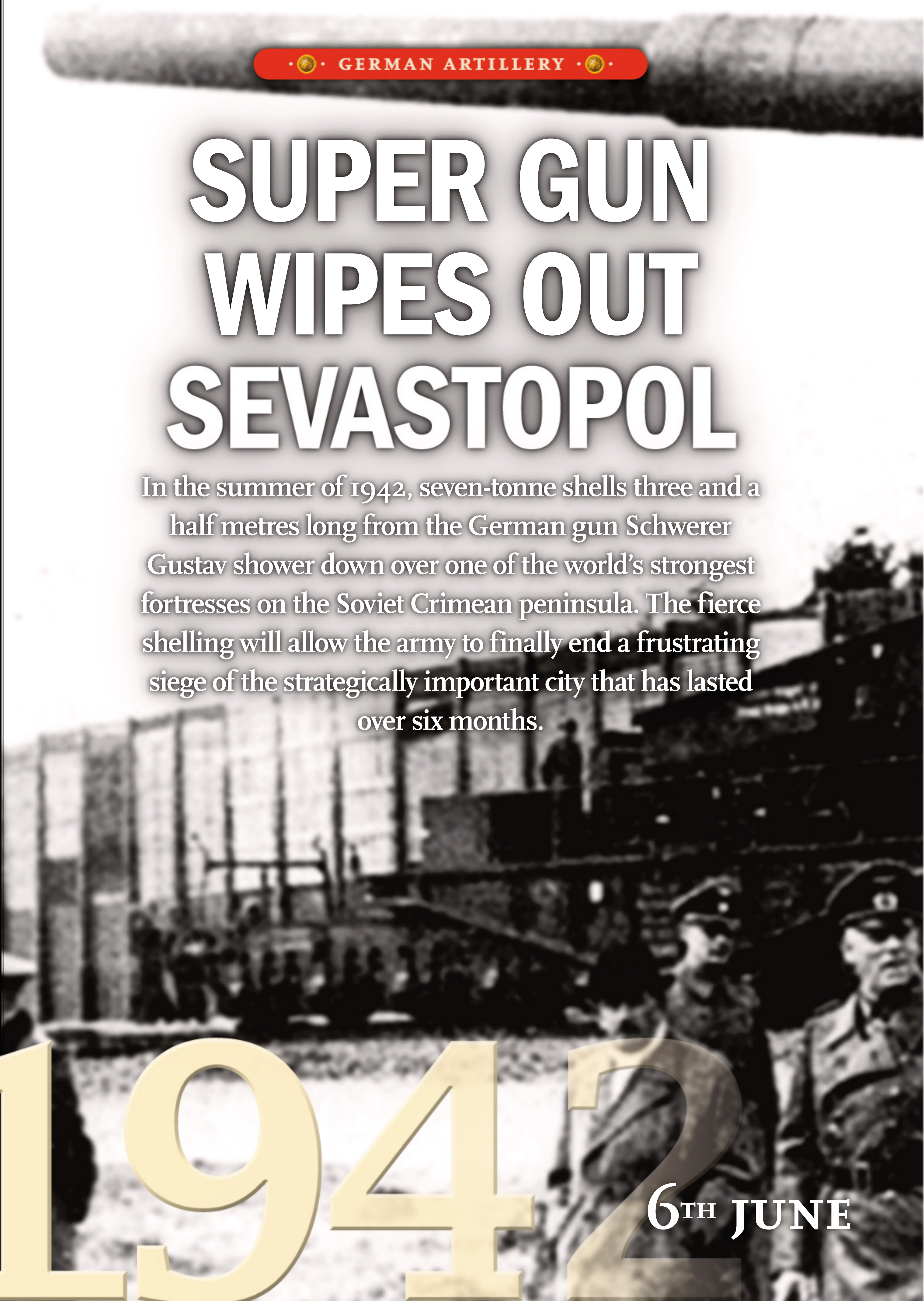


Negro
Length: 7.6 metres
Weight: 2.7 tonnes
Crew: 1





X-Class subs were crammed with instruments and controls, leaving the crew with virtually no room.



SUPER GUN WIPES OUT SEVASTOPOL

In the summer of 1942, seven-tonne shells three and a half metres long from the German gun Schwerer Gustav shower down over one of the world's strongest fortresses on the Soviet Crimean peninsula. The fierce shelling will allow the army to finally end a frustrating siege of the strategically important city that has lasted over six months.

1942

6TH JUNE

Albert Speer
Adolf Hitler

Adolf Hitler and Albert Speer join leading Nazis and officers to inspect the gun Schwerer Gustav.

Crimea, 1942

THE STAGE IS SET

In 1941, gun manufacturer Krupp supplies Hitler with a heavy gun more than 40 metres long and weighing 1,350 tonnes. The weapon arrives too late for its intended target of France, but in 1942 Hitler sees the steel monster as a solution to the Crimean problem, where the gun will crush the strong fortress at Sevastopol.

SOVIET UNION
Sevastopol

SEVEN TONNES OF ARMOUR-PIERCING SHELLS flew through the air near the port city of Sevastopol in the Soviet Crimea on 6th June, 1942. With great force, the projectile smashed through the water's surface on the Severnaya Bay beyond the city and continued to plough through 30 metres of deep water. The target was a large ammunition store, which the Red Army had hidden under the seabed. The shell drilled down through the sand and the bedrock before breaking through a thick protective wall of reinforced concrete that the Russians had moulded around the underwater depot. A powerful quake spread as the Russian bombs and shells ignited and detonated. The warehouse exploded like a volcano sending thick black smoke across the peninsula.

The Germans cheered. For several months they had tried to destroy the ammunition depot, but because of its location beneath the seabed it had not been possible. Thanks to the Wehrmacht's latest pride and joy – Schwerer Gustav (Heavy Gustav) – it had finally been successful. And the German army had high hopes that the 1,350 kg heavy railway gun could play a decisive role in capturing Sevastopol.

The Germans' belief in Schwerer Gustav was well-founded. During World War I, large, powerful guns had secured the German army important breakthroughs. Not least Big Bertha: this 420-mm howitzer from the Krupp factory had impressed by reducing the heavy concrete fortifications around the Belgian city of Liège to ruins. Big Bertha proved to be less effective against more recent fortifications, but the gun's successes convinced the Germans that bigger was better and that the development of more powerful artillery was the road to military superiority. When the French in the 1930s created the so-called Maginot line – a 300-kilometre-long chain of 58 fortified steel and concrete bunkers – Hitler decided to visit the Krupp factory in March 1935. Here the German dictator asked its owner, Gustav Krupp von Bohlen und Halbach, if it were possible to make a gun that could penetrate through the Maginot line's concrete walls. Krupp answered with a cautious "yes" and immediately set up a team with physics professor Erich Müller at its head to design the desired gun. At the beginning of 1937, engineers and researchers completed their calculations, and Krupp could show the drawings to Hitler's military experts. The result was impressive. Krupp promised that projectiles fired from the super gun could punch holes through both reinforced steel and concrete.

By the 1930s workers at Krupp already had steel safety helmets.

Hitler approved the project enthusiastically and allocated 10 million Reichsmarks for production. The Führer, however, stressed that the gun had to be completed by spring 1940.

HITLER WAS GIVEN A GIANT GUN AS A GIFT

That would not be the case. No one had previously built such a large gun, and production at Krupp's factory in Essen became drawn out. It wasn't until the end of 1941 that the gun

ARTILLERY

GIANT GUNS THUNDER THROUGH 500 YEARS

1464

The **Dardanelles Gun** was moulded in the form of an older Ottoman cannon. With a calibre of 630 mm, it was five metres long and almost 17 tonnes. It was used for the last time against British ships in 1807 during the Anglo-Turkish war.

1586

Measured by its calibre of 890 mm, the **Tsar Cannon** is one of the world's largest. The Tsar measures 5.34 metres and weighs more than 39 tonnes. It has been displayed in several places across Moscow, including Red Square. There is no evidence that the cannon was ever used in war, although studies reveal it has been fired at least once.

The Tsar Cannon stands in Moscow's Red Square to defend the Kremlin area.

1857

Mallet's Mortar was designed for use in the Crimean War, but wasn't completed in time. The British weapon had a calibre of 914 mm, was 3.4 metres long and could fire a tonne of heavy shells to a distance of around 2.5 kilometres. The cannon, which is a mortar, was built in parts so that it could be transported more easily.

Shells from Mallet's Mortar flew for 23 seconds before they hit.

The Germans moved into the outskirts of Sevastopol after Schwerer Gustav's job was done, in early July 1942.

was ready for its final test run. The trial firing took place on the shooting range in Rügenwalde in present-day Poland, and both Hitler and his chief architect – later Armaments Minister – Albert Speer were present. Dressed in a long leather jacket against the January cold, Hitler was pleased to note how Schwerer Gustav effortlessly drilled through the test line's armour plate to fully fulfil the manufacturer's promise. Krupp, who acted as personal host, then solemnly delivered the gun to Hitler as Krupp's contribution to the war effort.

By this time, however, Schwerer Gustav was no longer needed at the Maginot line. Hitler's forces had cleverly marched around the defences, and by spring 1940 had subjugated the vast majority of Western Europe in a few weeks. Hitler therefore believed that the gun could instead be deployed on the Eastern Front, where the Wehrmacht was encountering strong resistance from the Russians. The city of Sevastopol, which the German dictator had dubbed an "unsinkable aircraft carrier", lay on the Crimean Peninsula in the south-west of Soviet Union. It was important for the Germans, partly because it lay on the road to the important oil sources in the Caucasus and the Middle East, and partly because the Black Sea fleet had a base in the city.

The Black Sea Fleet had become a growing problem for the army. In the summer and autumn of 1941, aircraft from the naval base attacked the German forces at their most vulnerable point – their fuel supplies. Most of the important oil for German ships, tanks and planes came from the oil fields outside Ploesti in Romania, and during Russia's first attack on the fields and the surrounding refineries on 13th July, 1941, 9,000 tonnes of oil went up in smoke.

Five days later, a new attack destroyed another 2,000 tonnes of

»

1914

German gun **Big Bertha** pounded concrete fortifications in Belgium to dust with 800 kg of heavy shells at the outbreak of World War I.

The German gun Big Bertha weighed 42 tonnes.

1920

The British also developed large guns during World War I. The **BL18** railway howitzer had a calibre of 18 inches (457.2 mm) and a range of almost 21 kilometres. The weapon was only completed in 1920, so never made it into combat. One of the five guns made was used as part of UK defences in WWII.

1941

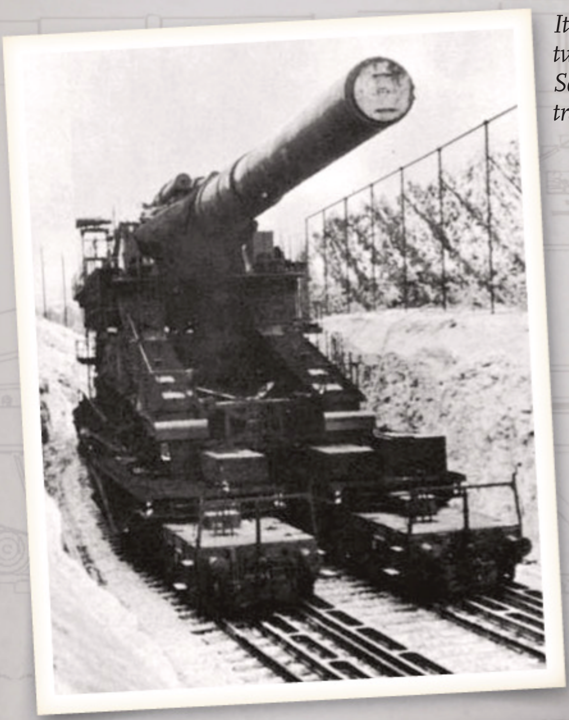
With a calibre of 910 mm, the US gun **Little David** surpassed the German's Schwerer Gustav. The Americans used Little David to test fire aerial bombs, but considered using it during the planned invasion of Japan. Little David was, however, never used in war.

Little David tested shells and was originally not considered to be a weapon.

WEAPON

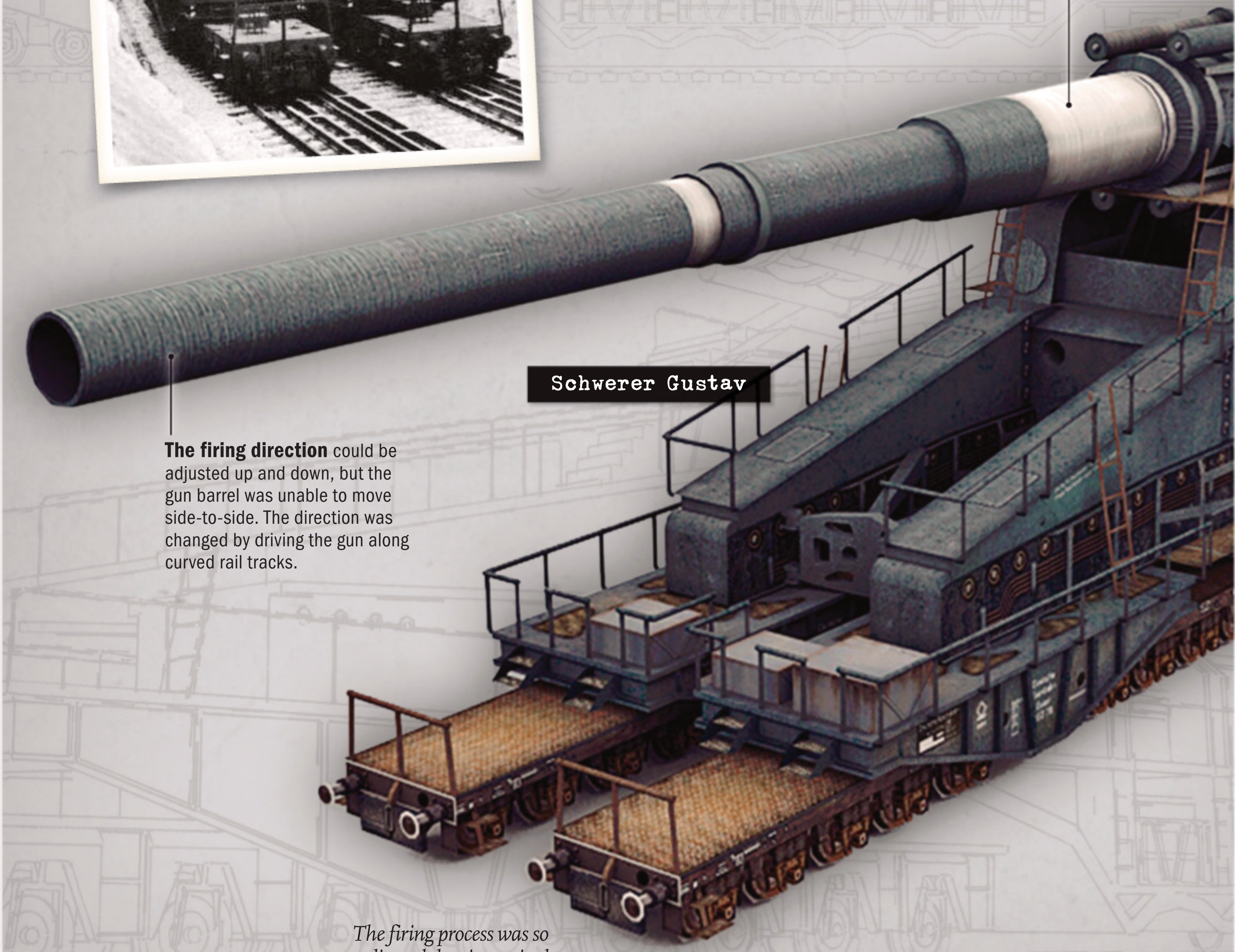
Gun only fired 14 shots a day

Before each shot, Schwerer Gustav required so many adjustments and fine tuning that the gun could only be fired a maximum of 14 times a day.



It took the Germans two months to transport Schwerer Gustav by train to Sevastopol.

The gun carriage weighed 400 tonnes and had to be separated into two parts during transport.



The firing direction could be adjusted up and down, but the gun barrel was unable to move side-to-side. The direction was changed by driving the gun along curved rail tracks.

The firing process was so complicated that it required the services of 250 artillerists.

oil. The amount of fuel lost would have fulfilled the needs of around 19,000 Tiger I tanks – a big loss for the Third Reich, which had only very limited fuel resources. Hitler saw only one option: to neuter Soviet forces in the region. A few days after the attack on 23rd July, 1941, the dictator issued a supplement to Führer Directive 33 stating that “the bulk of the infantry divisions will then occupy Ukraine, the Crimea, and the area of Central Russia up to the Don”. On 12th August, he decreed that Army Group South must “occupy the Crimean Peninsula, which is particularly dangerous as an enemy air base against the Romanian oilfields”.

RUSSIANS PROVIDED STIFF OPPOSITION

The task was assigned to Generaloberst (Colonel General) Ernst Erich von Manstein and the 11th Army. Von Manstein took over command on 17th September, 1941 and moved swiftly. On 1st November, the general had taken Simferopol, capital of Crimea, and it was followed by the fall of Kerch, another strategically important city, on 16th November. Now the Germans could tackle the port city of Sevastopol, which housed the Black Sea Fleet and the threat to the oil supplies.

But the city and the navy base were heavily fortified, and the German thrust was halted. The base was located on a promontory on the south-west tip of the Crimea, which made an attack from land extremely difficult. In addition to its natural defences, the Soviet fleet had secured itself with heavy artillery, which pointed at both land and sea. In addition, a hastily convened force of the city’s citizens had reinforced the fortress around Sevastopol with three defensive belts consisting of anti-tank trenches, barbed wire, bunkers and mines. A German attempt to take the city on 17th December failed, and after the Russians were able to force the Germans back from Moscow the following month, Hitler became increasingly desperate. In April, he called von Manstein to his headquarters, Wolf’s Lair in present-day Poland. Take Sevastopol no later than mid-August, the order sounded.

Von Manstein began his new offensive on 8th May, 1942 under good conditions. His 204,000-strong force was nearly twice the size of the Soviet defences, which numbered 106,000 under the command of General Ivan Petrov. There was also a disparity in the air forces: the Germans enjoyed massive support from VIII Air Corps and Air Fleet 4, which again was almost twice the size of the Soviet air force. Air superiority helped the Germans make a rapid advance during the first days of the offensive, but as the forces approached the city itself, von Manstein’s men met massive resistance.

SUPERGUN WAS CAMOUFLAGED

The Germans shots bounced off like hailstones when they hit the Soviet bunkers, which were made of reinforced concrete. The attacks were also hampered by the fact that many defensive installations proved impossible to destroy because they were dug into the ground. By the end of May the advance had once again been halted.

Help was on its way, however. In February, as the siege of Sevastopol slipped into deadlock, army command deployed »

FACTS

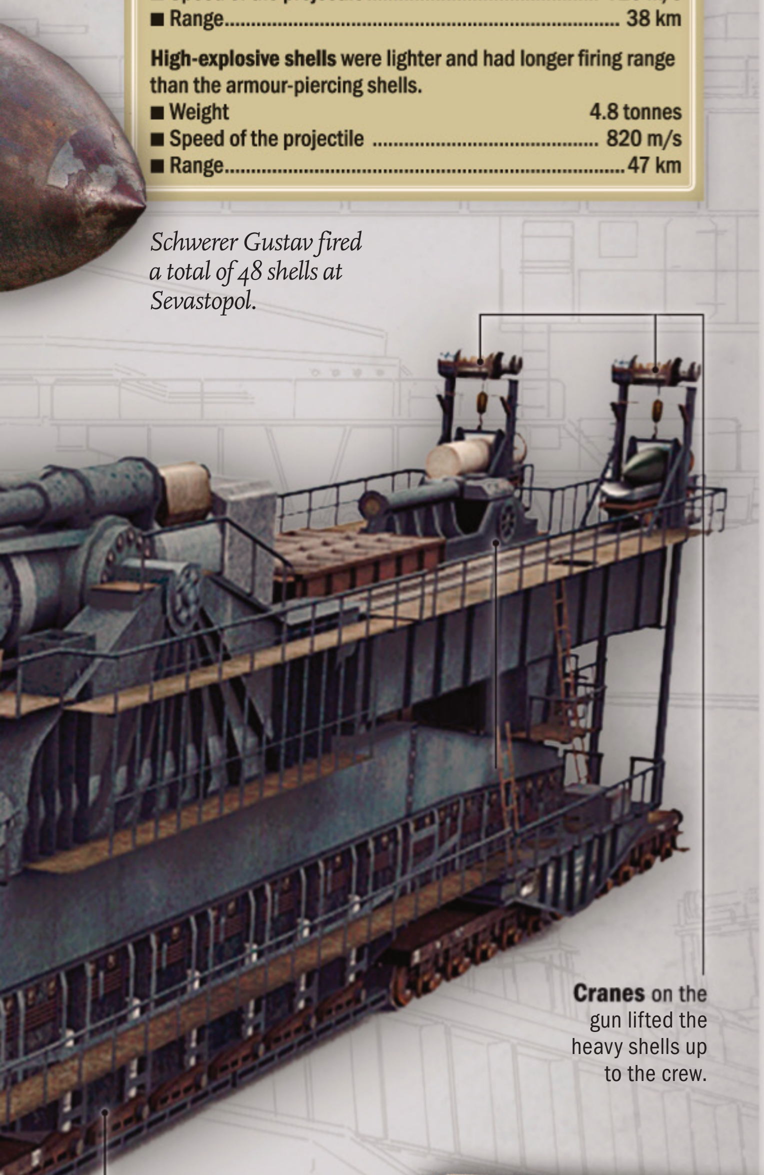
TWO TYPES OF SHELL

Armour-piercing shells were able to penetrate eight metres of steel concrete, one metre of steel or 32 metres of soil.

- Weight .... 7.1 tonnes
- Speed of the projectile .... 720 m/s
- Range .... 38 km

High-explosive shells were lighter and had longer firing range than the armour-piercing shells.

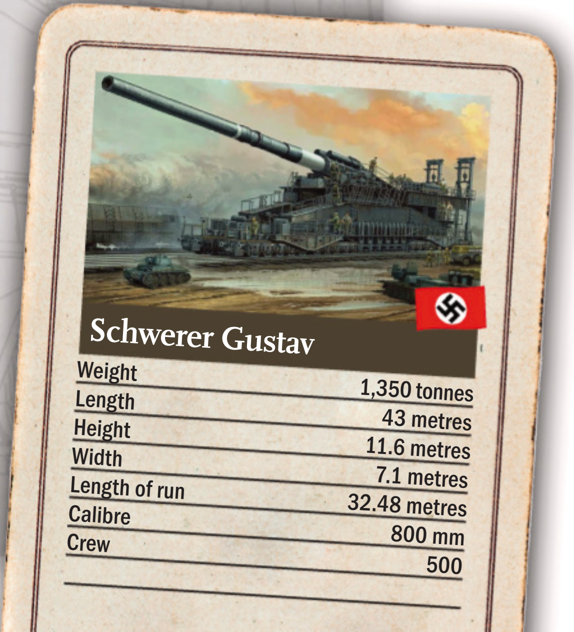
- Weight .... 4.8 tonnes
- Speed of the projectile .... 820 m/s
- Range .... 47 km



Schwerer Gustav fired a total of 48 shells at Sevastopol.

Cranes on the gun lifted the heavy shells up to the crew.

It took **eight carriages** to carry the gun carriage when it was assembled and made operational. During transportation to the front, Schwerer Gustav was divided into five parts, carried across 28 wagons.



Schwerer Gustav

Weight	1,350 tonnes
Length	43 metres
Height	11.6 metres
Width	7.1 metres
Length of run	32.48 metres
Calibre	800 mm
Crew	500

Schwerer Gustav to the Crimea. The operation was particularly suited to the giant weapon. The 40-metre-long gun couldn't be transported in one piece, but had to be split into parts and shipped using no less than 28 railway wagons, which formed a train 1.2 kilometres long.

The army chose to place the gun in the city of Bakhchysarai outside Sevastopol, where engineers and soldiers were busy digging a big trench. The intersection, resembling a sunken road, would serve both as a base for the giant gun and provide cover against air and artillery. The area was camouflaged in the hope of fooling the enemy. Engineering troops also worked on an area a kilometre away in an attempt to fool the Soviet forces and divert attention from the actual base.

The Germans built two sets of railway tracks: one set for Schwerer Gustav and one for the 110-kg heavy crane, which was required to both assemble and disassemble the gun. The gun was only able to change its direction of fire by following the curved tracks.

Russian medal given to participants in the defence of Sevastopol.

It was one thing to construct the railways, however, but quite something else to assemble the 1,350-tonne steel monster.

Gustav destroyed everything

About 2,000 men – craftsmen, infantry, anti-aircraft gunners and security police – were brought together to build Gustav. The entire process took around three weeks, but by early June Gustav was ready to fire on Sevastopol.

Von Manstein was excited. "It was a miracle of technical achievement", the general wrote in his memoirs. "The barrel must have been 90 feet long and the carriage as high as a two-storey house". On 2nd June, he launched another offensive against Sevastopol. The attack began with a massive bombing of the city, and three days later on 5th June at 05.35, Schwerer Gustav thundered for the first time. Coastal batteries were the gun's first target. The weapon fired its projectile at tremendous speed 12 kilometres into the air. One minute and 40 seconds later the shell crashed down on its target. After eight shots with the armour-piercing shells, the coastal batteries were in ruins.

The next day, Schwerer Gustav destroyed the underground ammunition store at the Severnaya Bay with nine armour-piercing shots. During the day, the giant gun pounded two more targets – fortified concrete positions that the Germans had dubbed Fort Stalin and Fort Molotov. But Schwerer Gustav had just begun. Over the following two weeks, the gun repeatedly rained its all-penetrating shells on Sevastopol's heavy fortifications. One by one, the concrete juggernauts evaporated into dust until the giant gun finally lay silent on 17th June. Over the space of 12 days, Schwerer Gustav had destroyed all its targets – either the defensive posts

It wasn't simply Sevastapol's forts that were destroyed – houses lay in ruins too after the German siege.

were crushed or so damaged that the Soviet crews abandoned them. The steel monster did with just 48 shells what 500,000 shells from other guns had not achieved earlier during the siege. The Germans were far from victory, however. The destruction of the forts did not lead to the Soviet troops' surrender. Stalin's forces were ready to defend Sevastopol by any means, and the long-standing siege of the city began to take its toll on the German soldiers.

"One lived only on cigarettes, cold coffee, tea and the sparse battle rations that were issued daily to those in the foremost lines. It was impossible to wash regularly or to shave", remembered Öbergefreiter (Senior Lance Corporal) Gottlob Bidermann later during the bombardment.

The Wehrmacht also met with other difficulties. Until 16th June, German aircraft controlled the airspace and bombed the city's port, storage facilities, hangars, barracks and supply depots with high explosive bombs. 1,800 sorties a day was common. But, by the end of June, the Luftwaffe was running out of both bombs and fuel, and the number of sorties fell by 40 percent. A quick victory at Sevastopol was needed.

Von Manstein decided to make a bold move. If his forces could cross the 600-metre-wide Severnaya Bay and overcome the last Soviet defences at Inkerman, a city five kilometres east of Sevastopol, they could move on into the city. The operation began shortly after midnight on 29th June. A fleet of 76 small ships sneaked across the narrow waters in the dead of night. The Germans took a huge risk – just one well-targeted salvo from one of the Soviet machine gun positions could have led to disastrous consequences for the light vessels. Luckily for von Manstein, the Soviet lookouts were too exhausted to discover the landing in time. By the time they smelled a rat, German infantry were already attacking the fortifications. After 45 minutes, the Germans reached the hills surrounding the landing point and moved further towards Sevastopol. After another six-day struggle, the Army finally defeated the city's defenders who surrendered on 5th July.

GUN DISAPPEARED WITHOUT A TRACE

The Germans suffered a loss of 35,866 dead and wounded during the siege while Petrov's coastal army was destroyed. The final battle alone took around 18,000 German and Russian lives, and when the city fell, the Wehrmacht claimed it had taken 95,000 Russian soldiers prisoner. However, the fighting wasn't just hard on the two armies – many of the city's 111,000 inhabitants died too.

Hitler appreciated von Manstein's efforts and promoted the colonel general to field marshal four days before the city fell. German troops celebrated the conquest during a victory parade in Sevastopol on 5th July, although a few scattered pockets of Russian troops continued to resist until 9th July.

A terrible fate now awaited Sevastopol. SS-Einsatzgruppe D began to systematically exterminate Jews and Soviet prisoners of war. The bodies were thrown into mass graves outside the city. Then the SS soldiers turned on civilians as they gassed them to death in special gas vans, known as "soul killers".

Following its efforts at Sevastopol, Schwerer Gustav's role was over. The steel monster was far too slow and difficult to move around to other fronts. The gun's fate is uncertain, but all indications suggest the weapon was sent back to Germany, where the Wehrmacht destroyed it at the end of the war.

Industrialist persuaded by rebuilding

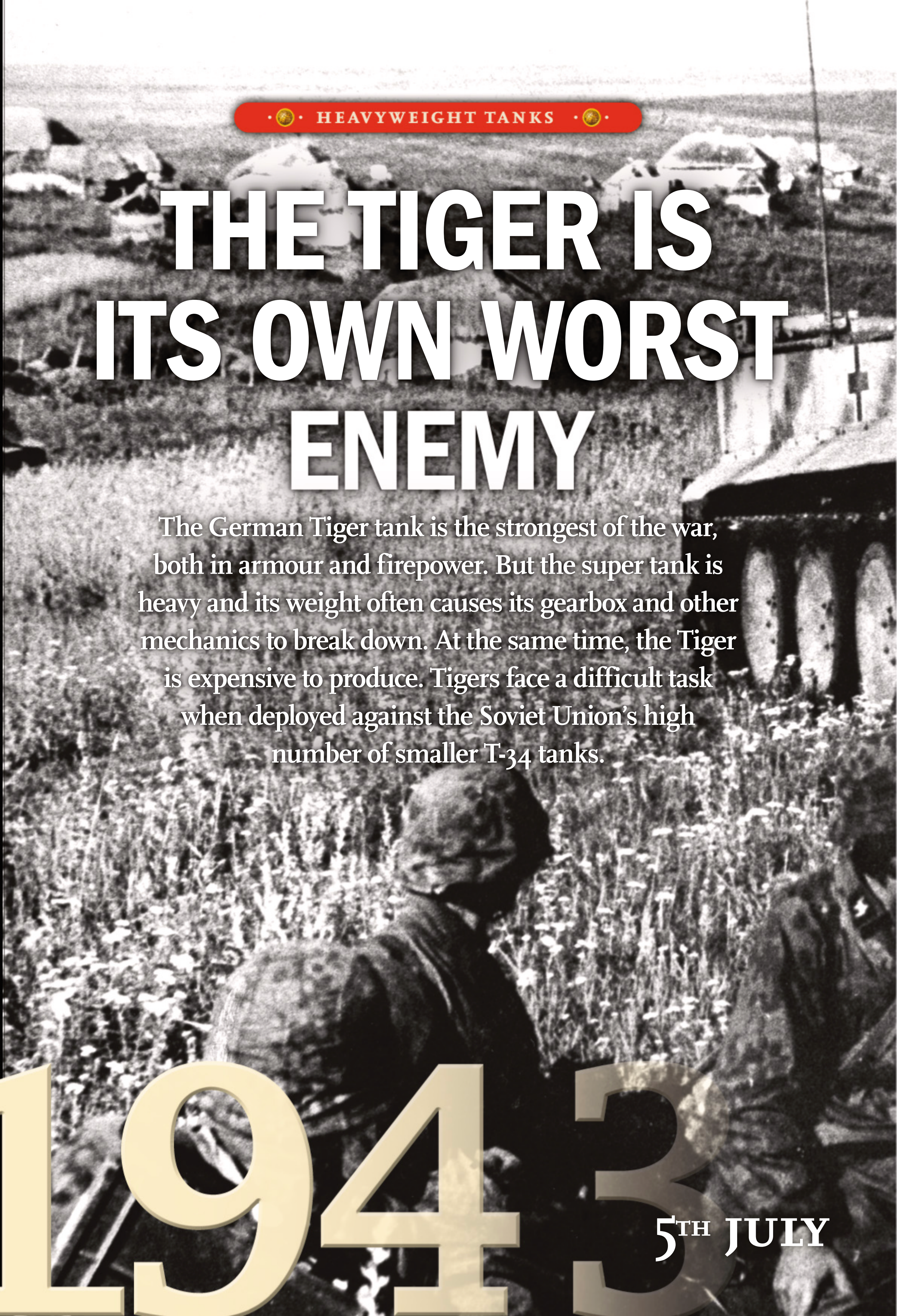
Industrialist Gustav Krupp was sceptical of Hitler, but changed his opinion when he heard about the Nazi leader's plans for rebuilding.

When Hitler was up for election in 1932, Gustav Krupp von Bohlen und Halbach – one of Germany's largest industrialists – didn't believe the man who would be Führer could provide the country with the stability it needed. Krupp changed his mind, however, when he heard of Hitler's plans to monumentally rebuild the nation. Almost overnight the industrialist became – as a friend later put it – a "super Nazi".

His about-turn paid off as Hitler's war preparation meant major orders and corresponding profits for his long-established family business, which specialised in steel and arms production. From 1933 to 1941 the value of his manufactured war equipment – including tanks, guns and ammunition – increased from **20,975,000** to **152,047,000** Reichsmarks. Production was cheap, as the workforce included concentration camp prisoners and PoWs who worked for free under miserable and slave-like conditions. A conservative estimate suggests around 100,000 people worked for Krupp under these conditions. Many starved or died from exhaustion.

The Krupp firm grew rapidly after the war and is today merged with Thyssen, another German steel giant.

Adolf Hitler congratulated Gustav Krupp on his 70th birthday in August 1940.



THE TIGER IS ITS OWN WORST ENEMY

The German Tiger tank is the strongest of the war, both in armour and firepower. But the super tank is heavy and its weight often causes its gearbox and other mechanics to break down. At the same time, the Tiger is expensive to produce. Tigers face a difficult task when deployed against the Soviet Union's high number of smaller T-34 tanks.

1943

5TH JULY

German soldiers move forward in a Tiger I during Operation Citadel in the Soviet Union in July 1943.

Soviet Union, 1943

THE STAGE IS SET

Tiger I tanks are being sent into the field on the Eastern Front. They must turn the fortunes of war in the Soviet Union after the Germans invaded in the summer of 1941 with tanks that are no match for the Russian T-34s. The Tiger may be a game changer: it can destroy T-34s before it comes within range of the Soviet tank.

SOVIET UNION

The earth shook under the tank's tracks, while its commander SS-Untersturmführer Michael Wittmann chose his next target from his seat atop the tank's gun turret. As usual, the taciturn Wittmann issued short, precise orders like "Turn left", "Target 100 metres" and "Go!"

Around 2,000 German and Soviet tanks were convened together on the great plain south of the Russian city of Kursk. Fighting had been almost uninterrupted on this battlefield since it had started a week earlier on 5th July, 1943. It was the largest tank battle the world has ever seen, but Wittmann could feel reasonably secure in his armoured skin: for the first time the 28-year-old SS officer was in command of Germany's top tank, the Tiger I, in a major battle.

Despite the Tiger's heavy weight, it reacted quickly to any threat. Instead of spending half a minute turning the heavy gun turret, Wittmann could turn the entire tank around in a few seconds. The medium Soviet T-34 tanks didn't stand a chance. Eight tanks, three anti-tank guns and a gun battery soon fell to Wittmann's Tiger I. The battle's approximately 70 other Tigers also pounded more Russian combat vehicles.

As darkness fell, the Russian plains were covered with charred bodies, and black columns of oily smoke rose from hundreds of burning wrecks. About 700 tanks had been shot to pieces.

Most were Soviet and German medium-sized tanks, but the Germans – despite losing the battle at Kursk – had not lost many Tigers. Also, Wittmann would be returning to his division, having just

1914-1944

NAME **MICHAEL WITTMANN**

TITLE TIGER COMMANDER

Ace destroyed 138 tanks

Michael Wittmann was one of Germany's best Tiger commanders, and during the war he was noted for the destruction of no less than 138 Allied tanks, 132 anti-tank guns and a number of anti-tank vehicles. In battle for the French town of Villers-Bocage with British forces, he hit 14 tanks, 15 trucks and two anti-tank guns on his own in the space of just 15 minutes.

The propaganda machine in Germany made great use of Wittmann, and the Bavarian-born SS soldier was portrayed as a hero. He was part of the Leibstandarte SS Adolf Hitler division that took part in the annexation of Austria and the Sudetenland. In the spring of 1941 he was assigned to the SS Panzer Regiment 1, commanding small tanks. By 1943 he was in command of Tiger 007 at the Battle of Kursk.

In 1944 Michael Wittmann's unit moved to Northern France to counter the Allied invasion. Here, the famed Tiger Commander and SS-Hauptsturmführer became a victim of a British tank strike on 8th August, 1944.

- **Received the Knight's Cross with Oak Leaves and Swords.**
- **Married five months before his death.**

made his name as the Nazi's undisputed champion tank commander. A large part of his success could be attributed to the Tiger, however, which had proved to be a formidable weapon since its introduction in 1942.

A 60-tonne Tiger I tank drives straight through houses in its path.

T-34 COULD NOT RETALIATE

By May 1941, Hitler had already ordered the military vehicles. He demanded strong armour, huge firepower and a waterproof hull with snorkel equipment, so the tank could cross the many rivers in France and the Soviet Union without problems.

While engineers worked on the tank, Hitler sent the German army into the Soviet Union in June 1941. The Wehrmacht countered any resistance and quickly occupied large areas of land, yet on one side, Hitler's army met unexpectedly stiff resistance: the Soviet T-34 tanks were far superior to the German Panzer and Panther models.

After almost a year – where the military vehicles' deficiencies had been exposed time and again – German engineers were able to give the armoured divisions some good news: the first Tiger I was ready. The Germans began training officers to serve on the advanced super tank immediately.

The new weapon was built for its firepower and impervious armour. With massive ammunition and fuel storage the giant weighed up to 60 tonnes. Nevertheless, it was not much slower than its enemies: in uneven terrain it could thunder at 20 km/h. Its top speed was twice that figure.

In autumn 1942 the Tigers were sent to the Eastern Front, and the Red Army quickly learned to fear its powerful 88-mm guns. In the right weather condition, a Tiger I could totally annihilate a Soviet T-34 from up to 2,200 metres away. At that distance, the T-34s could not retaliate.

New ammunition is loaded on board. The tank's armament included 92 armour-piercing shells.

SOLDIERS GOT "TIGER PHOBIA"

Despite the German defeat, the Tiger showed its worth in the Kursk and Kharkov battles in the summer and winter of 1943 respectively. During the month that the battle lasted, only 18 Tigers were lost – a result that was not unusual. During the war, the Tiger took out almost 10,000 enemy tanks for a loss of just 1,715 Tigers. The Red Army's fear of the tank was immense.

Soviet propaganda tried to strengthen troop morale by sending out false reports about the vulnerability of the Tigers. In the summer of 1943 the Soviet Union proclaimed that the Red Army defeated 10-12 Tigers a day.

The propaganda soon became so unrealistic that, after a couple of weeks, the Soviet Union claimed to have destroyed more Tigers than actually existed.

However, the Soviet's attempt to make Hitler's tank seem less fearsome didn't have much effect. Just the rumour that Tigers waited ahead was enough to spread terror through the Red Army.

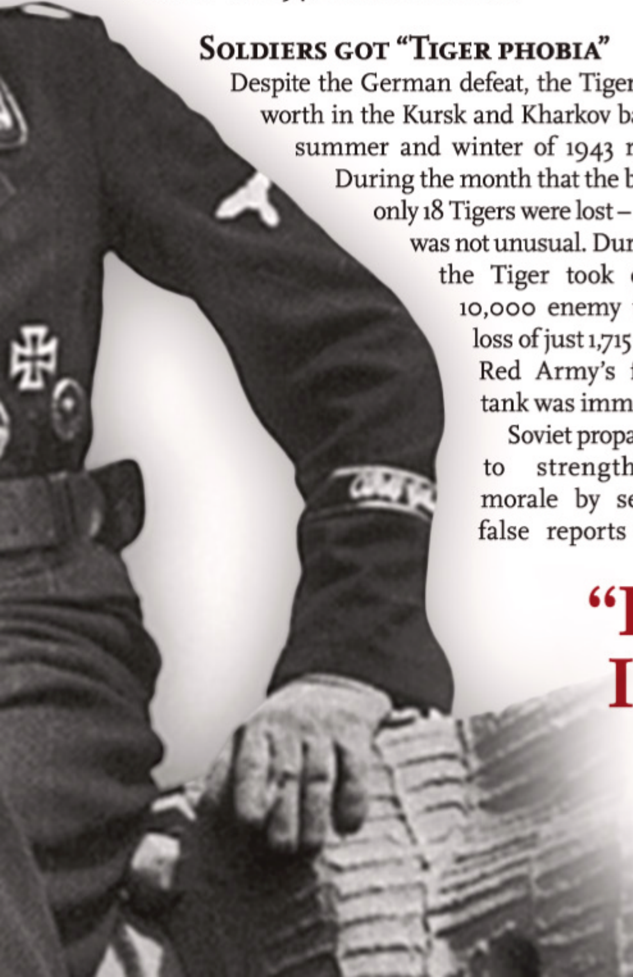
The Allies experienced a similar fear among its soldiers, which the British came to dub "Tiger phobia". In an attempt to curb his soldiers' fear of the superweapon, Field Marshal Bernard Montgomery forbade his officers to talk about the Tiger with the rank-and-file soldiers.

Several German tank commanders had also demonstrated that the enemy was wise to fear a Tiger I. For example, Wittmann defeated 117 enemy tanks during his seven first months as a Tiger commander.

THE ENEMY NEVER CAME WITHIN RANGE

Germany's famous tank divisions came to battle once again when 33 Soviet tanks broke through German lines in Ukraine on the morning of 8th January, 1944.

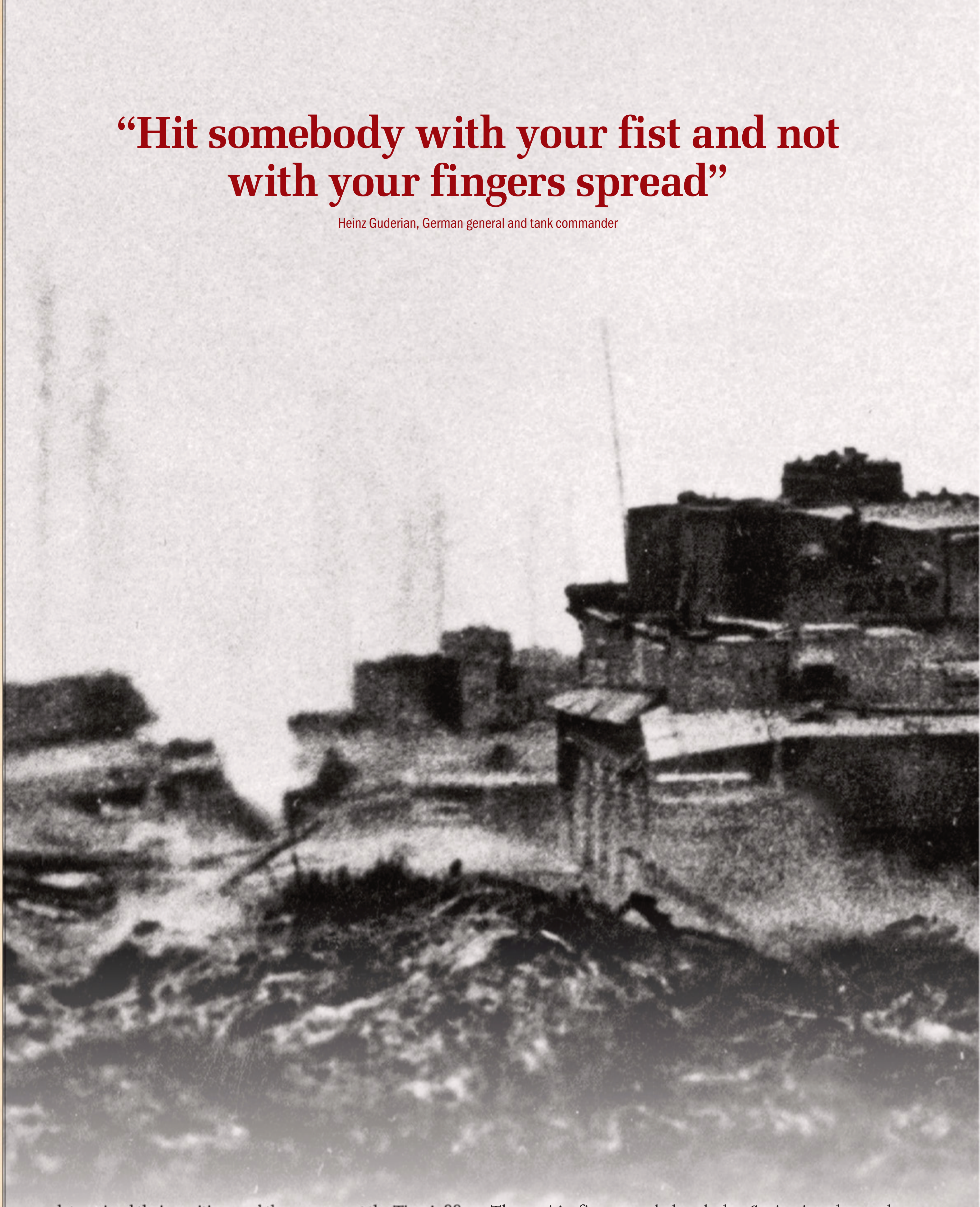
Wittmann turned up immediately. The now 29-year-old SS officer had 12 Tiger tanks under his command. Crackling machine guns, cannons and engine noise resonated over the snowy fields, but on this icy morning, low-lying fog prevented him from seeing far ahead. Suddenly, the enemy's tanks appeared in the ghost-like landscape. Wittmann



> **"In thankful appreciation… I award you… the Knight's Cross of the Iron Cross"**
>
> Adolf Hitler to Michael Wittman in January 1944

“Hit somebody with your fist and not with your fingers spread”

Heinz Guderian, German general and tank commander



determined their position, and the gunner set the Tiger’s 88-mm cannon. A shell blew up the turret of the first T-34.

Several other tanks had appeared in the meantime, and Wittmann had a myriad of targets to choose from. He created a furious wall of fire. A shell hammered into a T-34, which was about launch its weapon on the German battalion. Shortly after, Wittmann’s Tiger set its sights on another enemy tank. The unit’s fire overwhelmed the Soviet invaders, who hesitated – fatally. The Germans surrounded their tanks in a pincer movement, and four hours later they were defeated. 33 T-34s and seven guns were either out of action or in flames.

Once again, the Tiger had demonstrated its superiority against the Russian T-34s, which had less armour and a shorter range of fire. The Russians had to get within 1,600

The great German Tiger tank storms through the battlefield between the smaller Russian T-34s.

metres of a Tiger to destroy it, while the Tiger could promptly hit a T-34 from a distance of 2,200 metres.

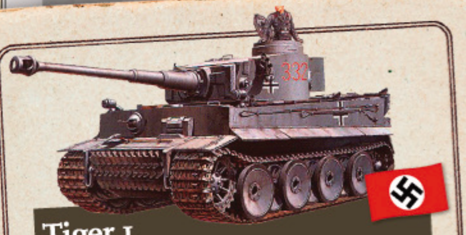
Tiger was too expensive too operate

But the Tiger's success was not enough to turn the fortune of war Hitler's way, and ironically it didn't help when in the summer of 1944 German engineers delivered the first improved version of the victorious super tank to the army: Tiger II, which was also dubbed the King.

The German army was now constantly retreating in winter-cold Eastern Europe – something the Tiger wasn't designed for. It already consumed huge amounts of fuel – 15 litres per kilometre driven – so in high snow or deep mud the demanding engine burned even more.

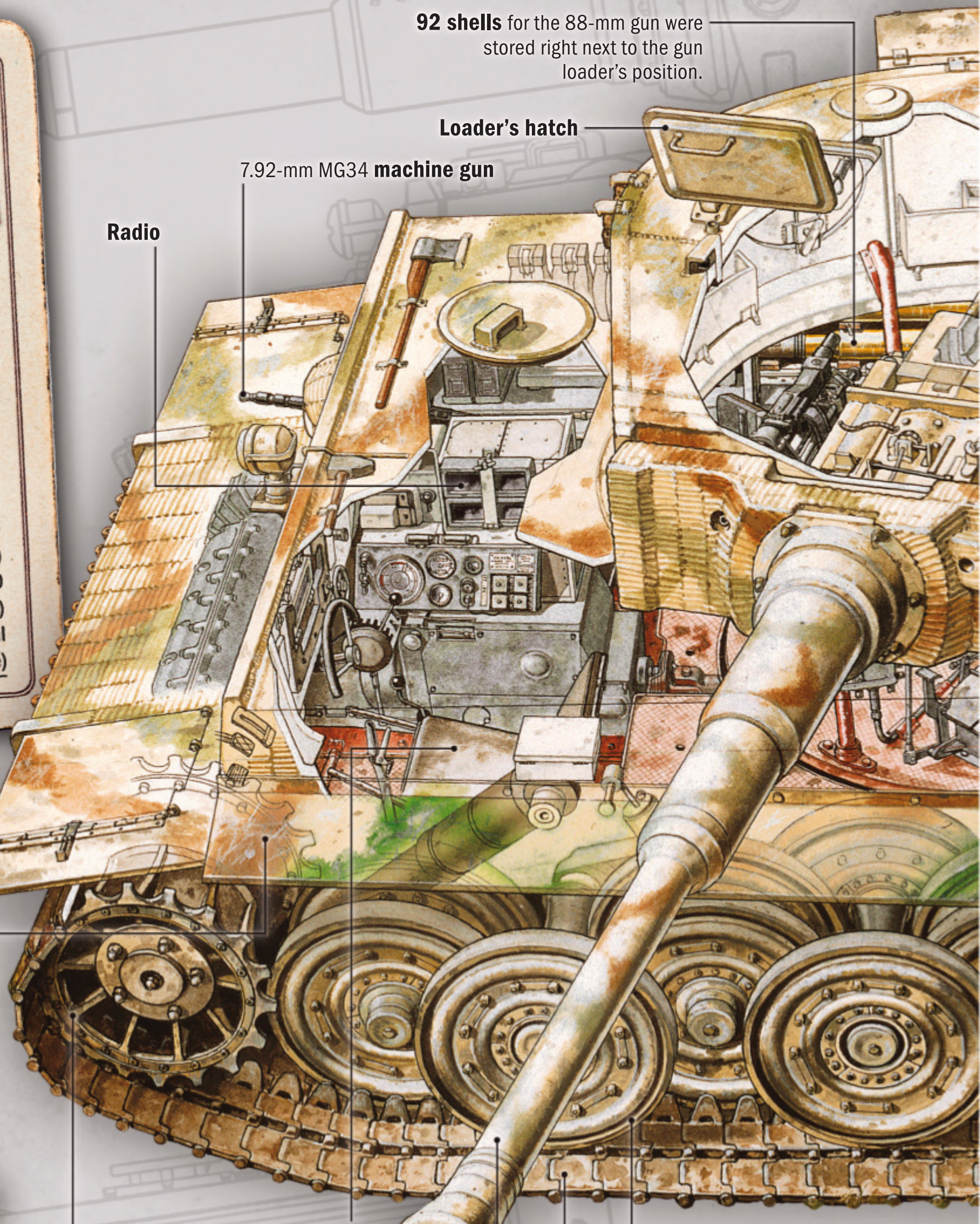
Tiger was a born killer

The German company Henschel & Sohn produced 1,347 Tiger I tanks. They were all equipped with the most advanced technology that Nazi Germany could provide.



Tiger I

Crew	5
Height	3.00 m
Width	3.70 m
Length w/wo cannon	8.45 m/6.31 m
Weight	57,800 kg
Engine	Maybach HL230 V12 petrol engine
Maximum range (at cruising speed)	195 km
Armament	1 x 88-mm Kwk 36 L/56 cannon 2 x 7.92-mm MG34 machine guns
Ammunition	PzGr 39 (armour-piercing shells) PzGr 40 (armour-piercing shells, tungsten core) Gr 39 Hl (shells, hollow charge)


Loader's hatch
7.92-mm MG34 **machine gun**
Radio
Driver's seat
Shock absorber
Gunner's seat
Rubber-padded steel deck
88-mm Kwk 36 L/56 **cannon**

92 shells for the 88-mm gun were stored right next to the gun loader's position.

From September 1943, engineers covered the Tigers with a non-magnetic anti-mine coating **(Zimmerit)**.

The **caterpillar tracks** were extremely wide. The belts, measuring 72.5 cm, ensured that the heavy tank did not get hopelessly stuck in the mud.

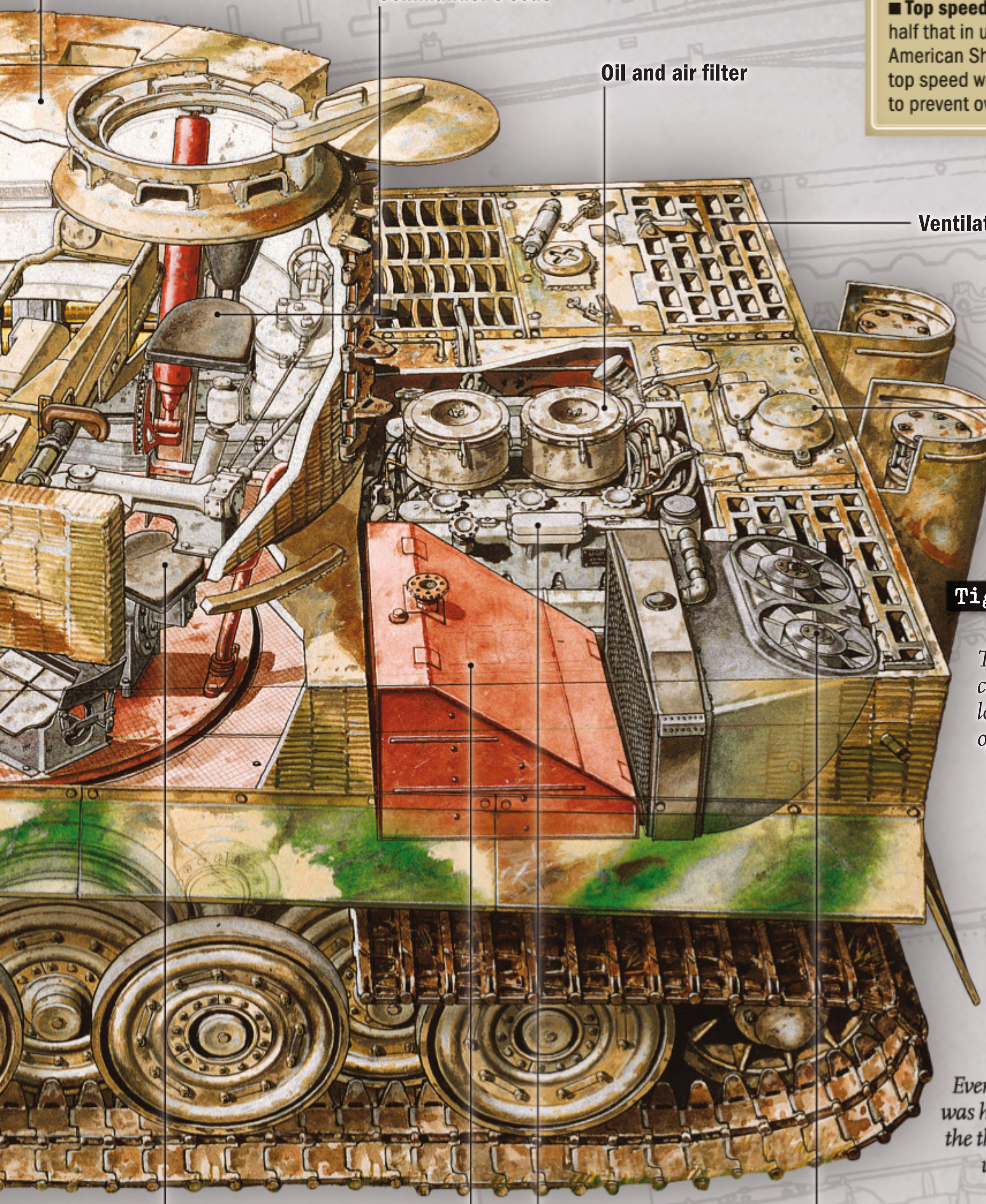
With a little luck, a hand grenade could be slipped into a gun barrel.

The turret weighed 11 tonnes and rotated very slowly – it took about a minute to turn 360 degrees. It was actually quicker to turn the whole tank.

EASY TO ROTATE

FACTS

- **The hydraulic steering system** meant that the caterpillar tracks could drive each way, and the Tiger could turn on its axis in just 3.44 metres.
- **Top speed** was 45.4 kilometres per hour and about half that in uneven terrain. The Soviet T-34 and the American Sherman were only slightly faster. The Tiger's top speed was later reduced to 38 kilometres per hour to prevent overloading the engines and gears.



The snorkel and watertight hull allowed the Tiger to ford rivers 4.5 metres deep. Only the first 495 Tigers were equipped with snorkels.

The engine was perfect for a lighter tank, but barely sufficient for the Tiger's weight. After 250 had been built, the engine was upgraded.

Tiger I

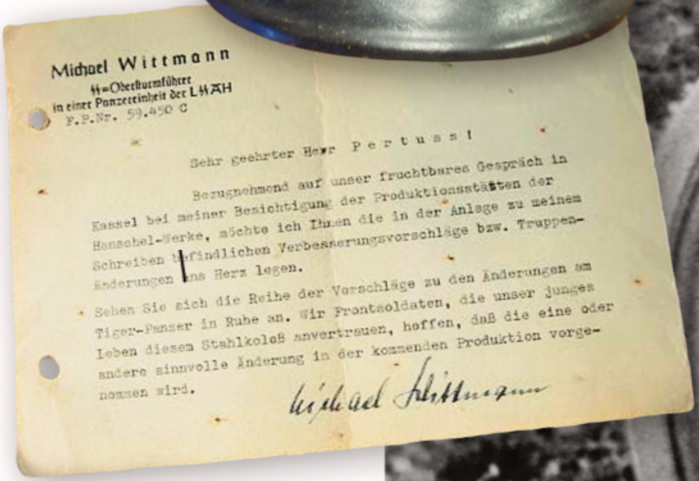
The crew consisted of a commander, gunner, loader, driver and radio operator.

Even if the Tiger was hit by a shell, the thick armour usually held.

The Tiger's efficient 88-mm gun was the same type used by anti-aircraft units.

"Tigers and Panthers don't eat hay", exclaimed a German officer despairingly in the winter of 1944. Another problem was the weight of the tanks, which tested the Tiger's suspension, gearbox and other vital parts to the extreme. Uneven terrain, high speeds or long stretches often caused the mechanics to break completely. In fact, a Tiger tank rarely managed a long march without breaking down.

The mechanical problems were a big deal for the Germans, and it was not long before the Allies discovered their weaknesses. For example, in the summer of 1944 British soldiers found some broken-down Tigers in Italy. The discovery caused quite a stir among British Army commanders, who had been looking for a way to defeat the tank. They set up a group to investigate the tanks, and in August they came to a somewhat surprising conclusion in the report "Who killed the Tiger?" It killed itself.



Michael Wittmann
ᛋᛋ=Obersturmführer
in einer Panzereinheit der LᛋᛋAH
F.P.Nr. 59.450 C

Sehr geehrter Herr Pertuss!

Bezugnehmend auf unser fruchtbares Gespräch in Kassel bei meiner Besichtigung der Produktionsstätten der Henschel-Werke, möchte ich Ihnen die in der Anlage zu meinem Schreiben befindlichen Verbesserungsvorschläge bzw. Truppen-Änderungen ans Herz legen.

Sehen Sie sich die Reihe der Vorschläge zu den Änderungen am Tiger-Panzer in Ruhe an. Wir Frontsoldaten, die unser junges Leben diesem Stahlkoloß anvertrauen, hoffen, daß die eine oder andere sinnvolle Änderung in der kommenden Produktion vorgenommen wird.

Michael Wittmann

Michael Wittmann wrote a letter to the Henschel plant with suggestions for improvements of the Tiger.

The Wehrmacht had spent years trying to keep the Tiger's technical problems secret. But the mechanics were a constant headache for the tank drivers. For example, they had to lift the 11-tonne turret with a crane to replace the gearbox. In addition, there didn't have to be much frost on the Eastern Front's slippery roads before the mud froze between the wheels. Often the crew had to remove the massive wheels to scrape them free of ice. Such repairs were time-consuming and awkward in perfect conditions. On an ice-cold and muddy battlefield, the task was almost impossible. Many Tiger drivers had to reluctantly blow up their valuable tanks and walk away on foot, so the enemy wouldn't get hold of them.

The problems led to the German tank battalions never having the luxury of enough combat-ready Tigers to strike a decisive blow. At the same time, they were hampered by a lack of skilled commanders. Therefore, young and inexperienced officers were often given command of a Tiger with the message: "Be careful, you've got a million marks and »

"The engine of the Panzer is a weapon just as the main-gun"

Heinz Guderian, German general and tank commander

In a break in the midst of war, a Tiger radio operator makes sandwiches for himself and his comrades.

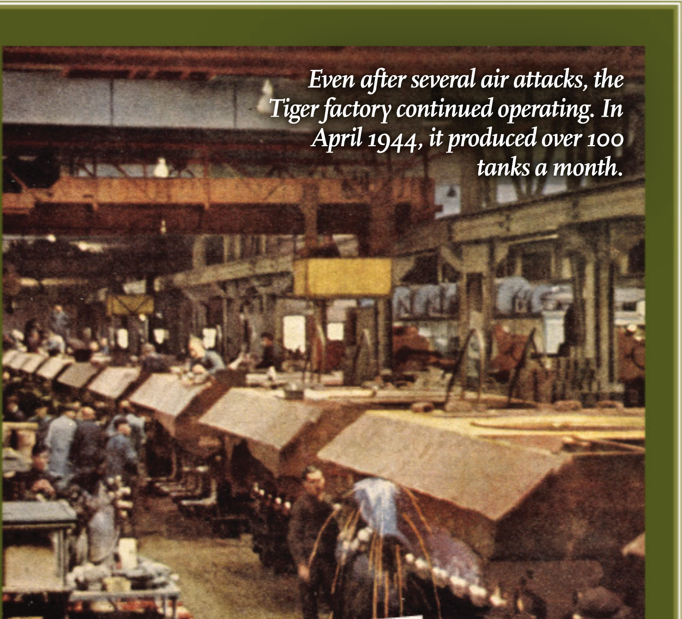
Factory supplied tanks to the end

The city of Kassel was the centre of Tiger production. The German arms manufacturer Henschel & Sohn built tanks until April 1945.

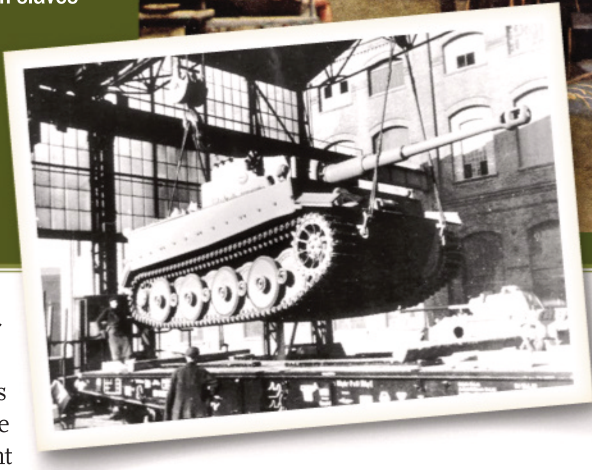
The Tiger was so packed with advanced mechanics that Henschel & Sohn factory in Kassel took 300,000 man hours constructing a single tank. This was double the production time of other German tanks.

In 1942, the Kassel plant only produced about 25 units a month, which failed to cover the German Army's demand. Therefore, the factory had to switch to manufacturing seven days a week, and in April 1944 it produced over 100 Tigers a month. More than 8,000 men were in work and many of them were Jewish slaves who were worked to death.

On 1st April, 1945, the American army reached Kassel, but Henschel & Sohn continued undeterred and delivered 13 Tigers the same day to two German companies. On 4th April, the Americans finally captured Kassel and production stopped forever.



Even after several air attacks, the Tiger factory continued operating. In April 1944, it produced over 100 tanks a month.



A finished Tiger is loaded on a railway car in Kassel in 1942.

three and a half million working hours under your arse".

The men's inexperience resulted in many Tigers simply breaking down because they were overloaded. Often they did not even reach the front before they broke down. Fortunately for the Nazis, a significant number of tank commanders weren't incompetent. Wittmann destroyed a total of 138 enemy tanks – but even his luck couldn't hold forever.

WITTMANN DIED WITH THE TIGER

In 1944 Wittmann was sent to north-western France, where on 8th August, 1944 the Allies launched a major offensive.

Wittmann went to help the German soldiers against the superior force they faced, but after only one hour of battle his Tiger was in flames. When the tank exploded from the inside, the pressure was so violent that the 11-tonne turret was blown off.

The great Nazi hero died together with his men, and his death sent shock waves through the battalion.

Most battle-ready Tigers were wrecked over the following month. Some were destroyed by fierce shelling, but a great many were blown to pieces by the German army. Spare parts and fuel were now impossible to come by, and the Germans refused to let the precious tanks fall into enemy hands.

THE TIGER II ARRIVED TOO LATE

Neither could the Tiger II reverse the war for the Germans. The updated version of the Tiger was as difficult to produce as its predecessor, and Henschel & Sohn only built 492 Tiger IIs. They were too few to have a decisive influence on the war.

The Tiger II was first put into service in July 1944, and was reputedly used during combat in Normandy, where Allied troops began their liberation of Europe. On the Eastern Front, Tiger II first participated in sorties in August of the same year – far too late to stop the Soviets' rapid advance.

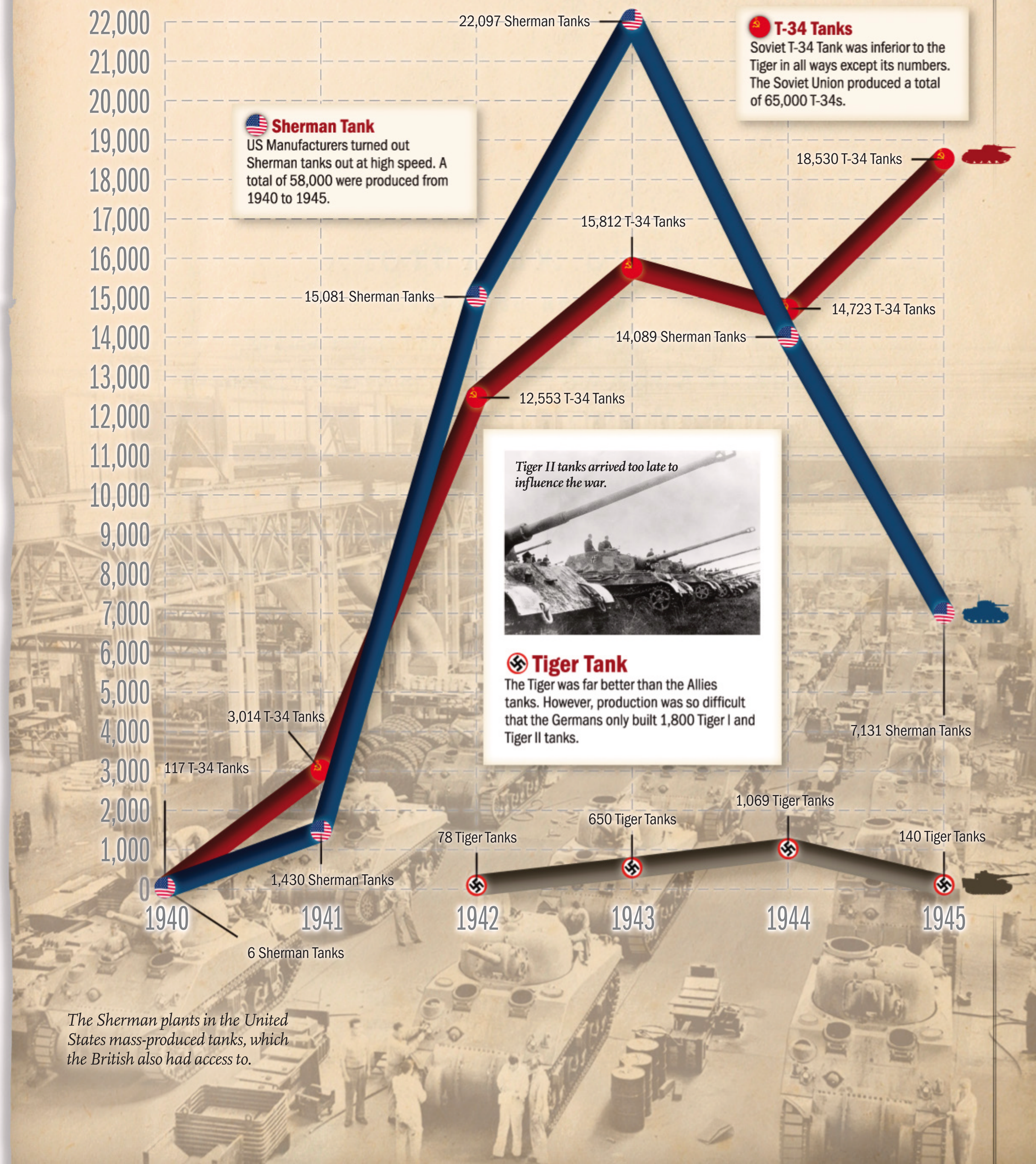
When Nazi Germany finally surrendered in 1945, the few remaining Tigers were shown to have no value for the Allies – they required too many expensive spare parts. Therefore, Tiger production never resumed – despite its superior strength.

> **"He was a fighter in every way, he lived and breathed action"**
>
> SS-Obergruppenführer Josef "Sepp" Dietrich after Michael Wittmann's death

Greater numbers won over size

Every Tiger wiped out an average of 5.74 enemy tanks. But the tank couldn't turn the war when the United States and the Soviet Union built up a combined total of 123,000 Sherman and T-34 tanks to counter the 1,800 German Tigers.

Michael Wittmann received a series of honours for his kills as Tiger commander.



T-34 Tanks
Soviet T-34 Tank was inferior to the Tiger in all ways except its numbers. The Soviet Union produced a total of 65,000 T-34s.

Sherman Tank
US Manufacturers turned out Sherman tanks out at high speed. A total of 58,000 were produced from 1940 to 1945.

Tiger II tanks arrived too late to influence the war.

Tiger Tank
The Tiger was far better than the Allies tanks. However, production was so difficult that the Germans only built 1,800 Tiger I and Tiger II tanks.

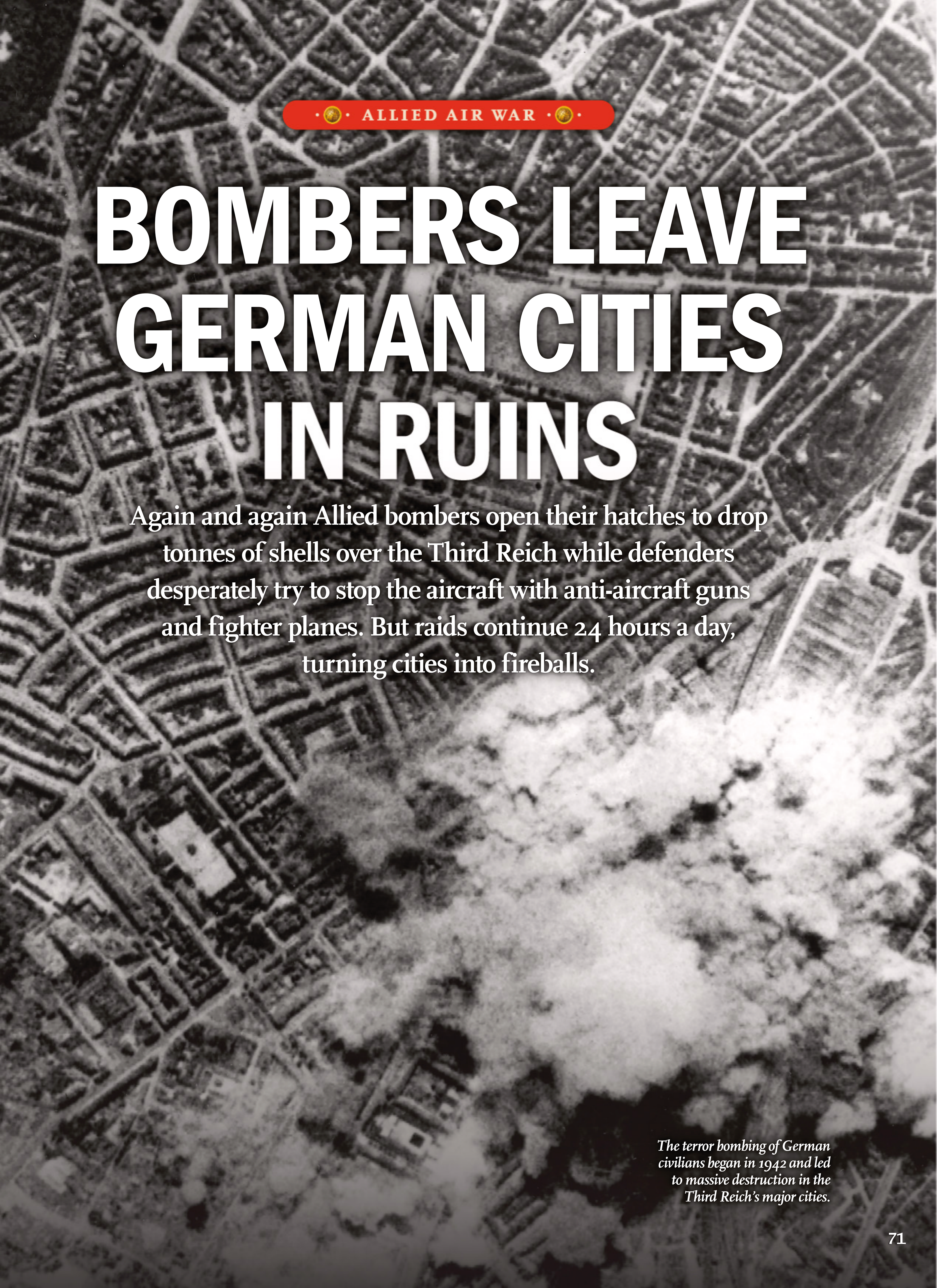
The Sherman plants in the United States mass-produced tanks, which the British also had access to.

1944

30th MARCH

BOMBERS LEAVE GERMAN CITIES IN RUINS

Again and again Allied bombers open their hatches to drop tonnes of shells over the Third Reich while defenders desperately try to stop the aircraft with anti-aircraft guns and fighter planes. But raids continue 24 hours a day, turning cities into fireballs.



The terror bombing of German civilians began in 1942 and led to massive destruction in the Third Reich's major cities.

Germany, 1944

THE STAGE IS SET

In the first year of the war, German civilians weren't greatly affected by the war. Allied air strikes against Nazis' military industries inflicted only minor damage. But now the British have switched strategy: huge waves of bombers carpet-bomb residential areas to force the Third Reich to surrender.

The Bomber Command insignia indicated if the wearer was a gunner (AG) or navigator (N).

Wing Commander Francis William Thompson peered through the small square windshields of his Lancaster bomber with concern. Cloud cover over the horizon was decreasing and the British pilot was aware his bomber – named Z-Zebra – would be clearly visible against the night sky. The weather forecast from that afternoon's briefing on 30th March, 1944 had obviously been wrong, and now the Lancaster flew with hundreds of other British bombers across the moonlit European continent, where the German night fighters and anti-aircraft defenders were waiting.

"Navigator to Skipper. The Met forecast winds are all bull. Heavy tail winds have given us an incredible groundspeed", reported navigator Tony Stancer from the nose of the plane, adding to Thompson's concerns.

The pilot would have to adjust the 30-tonne and 21-metre-long plane's course to perform "dog-leg" turns to slow down their progress towards the night's target of Nuremberg – the bomber wave was expected to arrive in the south German industrial city at specified intervals. But as Thompson swung the plane for the first dog-leg, the radio chirped again:

"Unidentified aircraft coming towards us: port quarter", warned Flight Sergeant Tommy Hall from Z-Zebra's rear.

Thompson was just about to throw the plane into a dive as the giant shadow of a Halifax bomber appeared over the cockpit window. Just eight metres – 25 feet – separated the pair of British bombers. "Jeeze, that was close!" someone buzzed over the intercom. All seven crew members in Z-Zebra were left in no doubt the airspace situation was chaotic because the wind speed made it difficult to keep to the agreed speed and position.

On the other hand, however, the crew encountered no enemy fighters as Z-Zebra left the English Channel behind and flew across the Belgian coast. The men hoped the raid's first wave of Mosquito bombers had been successful with a planned diversionary move – attacking targets some way from the Nuremberg route to lure German fighters away from the actual target.

Their hopes were dashed as Z-Zebra approached Frankfurt – it was clear the enemy had no intention of letting the 800-odd British aircraft fly freely through German airspace. Hall, manning the rear-gunner position, suddenly spotted an enemy fighter through the rear windows and screamed to Thompson to make the plane dive. The Lancaster swung right and turned its nose to the ground. The enemy followed the move, but when Thompson performed another evasive manoeuvre, he lost the German pilot, leaving him to chase another bomber crew.

For the second time, the Z-Zebra crew had barely escaped death – and the British hadn't even reached their target in Nuremberg,

The victims of the raid on Dresden on 13th-14th February, 1945 were placed in large piles in the city square and burned.

where anti-aircraft artillery would subject the plane to massive shelling. Despite the huge costs of air attacks, however, the Allies had no intention of halting their bombing campaigns.

Tracer projectiles helped air defences determine if their targeting was correct.

British set Germany on fire

When Thompson and his men risked their lives in Europe in March 1944, dangerous bombing raids over Germany were nothing new for Bomber Command – the RAF's offensive air force behind the tactical and strategic bombings.

The first crews had arrived in darkness over Berlin to drop 81 bombs on the capital's airport from as early as August 1940, but those bombers – around 50,000 in total – that flew to Germany during the first two years of the war did little damage to the country's war industry. The British were forced to rethink their plans, dropping small specific goals such as railways and military installations in favour of much wider targets – major cities where civilian areas would be carpet-bombed.

"The primary object of your operations should now be focussed on the morale of the enemy civilian population and, in particular, of the industrial workers", stated an internal document from the Air Ministry, which landed on the table of the Bomber Command staff room in February 1942.

The launch of the new strategy – "area bombing" – was accompanied by the appointment of a new leader of Bomber Command: Arthur Harris. The 49-year-old British air marshal – nicknamed "Bomber" – had no qualms that the target was now ordinary Germans. Both Harris and Winston Churchill swept any moral scruples off the table – the Germans had bombed British citizens during the Battle of Britain after all, and without a foothold on the European mainland, the British could only attack from the air. The air marshal stated he would destroy everything German.

"There are a lot of people who say that bombing cannot win the war. My reply to that is that it has never been tried yet. We shall see", Harris stated coolly, shortly after his appointment.

The Lancaster and Halifax heavy bombers sported four engines to allow them to fly far and carry huge deadly loads while new aircraft, the lightning-fast Mosquitoes, were used in pathfinder squadrons to mark the targets with target flares so the heavy bombers had something to aim for. The Mosquitoes also dropped thousands of metal foil strips to confuse the enemy. These strips blindsided German radar, which existed to guide the night fighters and provide air defences with information, so their anti-aircraft guns were as precise and deadly as possible.

Bombers were met with fire from flak guns with a calibre of up to 128 millimetres.

But even though British techniques had been refined, engines tuned and attacks bigger than before, the Germans were still not on their knees in the summer of 1943, by which point Harris had been bombing German cities for over a year – with help from the US Air Force that had linked up with the RAF in 1942.

In July 1943, Bomber Command made its brutal breakthrough when Harris sent more than 3,000 planes to Hamburg in the space of a week as part of Operation Gomorrah. The Germans were to be served notice of how the enemy's bombing could turn a peaceful summer's night into an infernal hell.

Fire-stormed inhabitants of Hamburg

The clock in Hamburg's bell tower was about to strike one in the morning on 25th July, 1943 when an armada of British bombers caught the North German city's inhabitants unawares. Mathilde Wolff-Mönckeberg had just reached the safety of a bunker when the first bombs tore houses to pieces and ignited anything combustible. The 64-year-old professor's wife had spent many hours in the bunker during numerous attacks over the past year, but the bombing of 25th July was unusually frightening:

"The house shakes, the window tremble and it is completely different from any of the other times", she noted later.

The many tonnes of incendiary fire bombs had a particularly devastating effect, flames flaring through the city's narrow alleys like a powerful hurricane. "Children were torn away from their parents' hands by the force of the hurricane and whirled into the fire", a local police report stated.

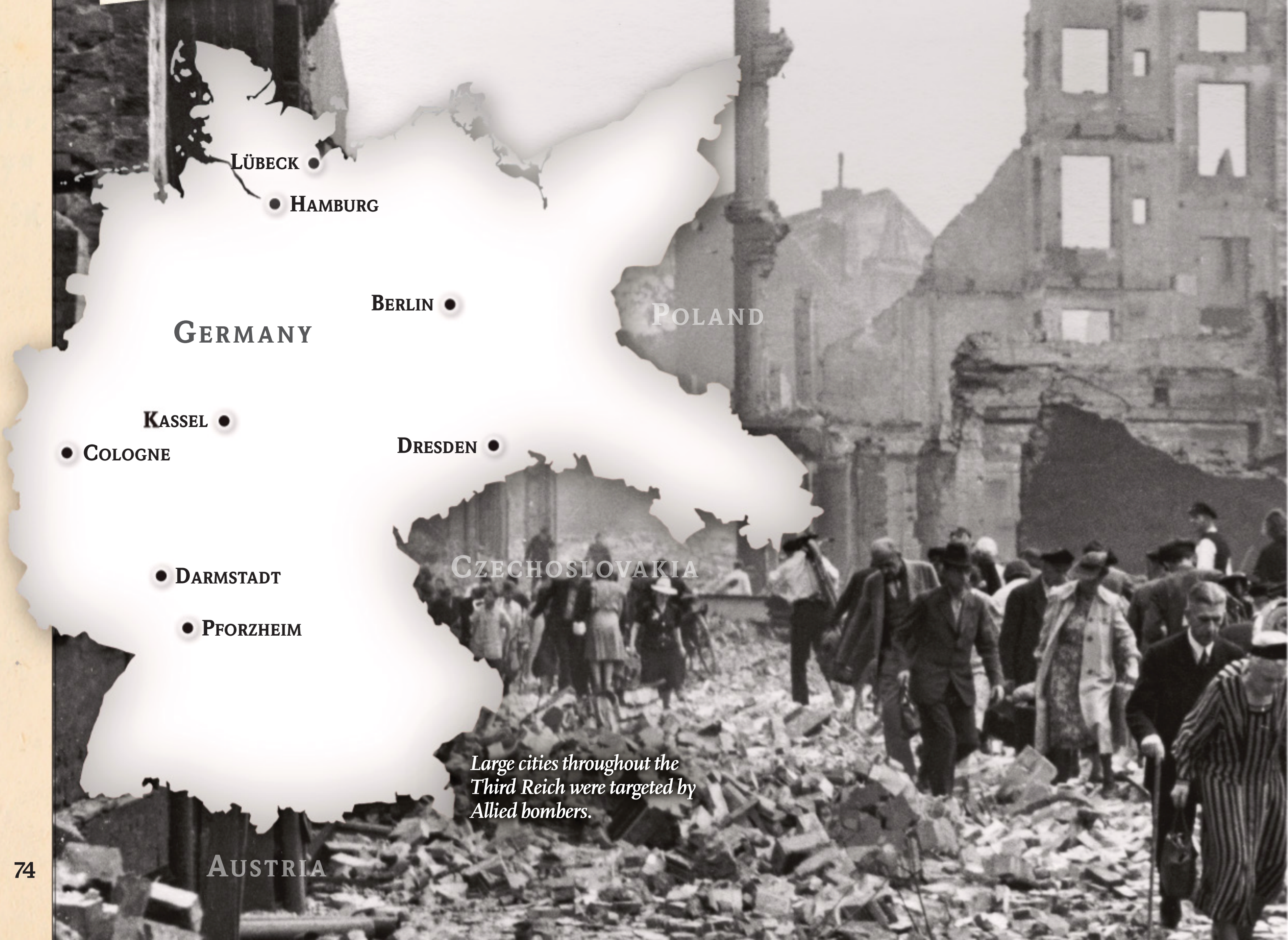
The violent firestorm sucked all the oxygen from the air, and the city's residents were forced to leave their shelters where its absence was particularly acute. Above on the cobblestones and scorching asphalt roads, however, the lack of air left citizens gasping for breath before eventually collapsing on the ground; if they survived this, an even more painful

Hitler Youth boys helped to recover charred bodies from the ruins.

Several thousand people lost their lives in one day

The Allied air bombings of Nazi countries killed more than 600,000 civilians during the war. More than 1,000 residents died in just one day during massive concentrated raids on major German cities.

TARGET OF RAID	DATE	ATTACKING NATION	SIZE OF FORCE	GERMAN LOSSES
• **LÜBECK** *Around 170,000 inhabitants*	28th-29th March, 1942	🇬🇧	• 234 bombers	Between 300 and 1,000 dead
• **COLOGNE** *Around 648,000 inhabitants*	30th-31st May, 1942	🇬🇧	• 1,046 bombers	469 dead
• **HAMBURG** *About 1,700,000 inhabitants (as of December 1940)*	25th July-3rd August, 1943	🇬🇧🇺🇸	• 3,000 bombers	42,600 dead
• **KASSEL** *About 225,000 inhabitants*	22nd-23rd October, 1943	🇬🇧	• 569 bombers	At least 10,000 dead
• **DARMSTADT** *Population: unknown*	11th-12th September, 1944	🇬🇧	• 240 bombers	12,300 dead
• **BERLIN** *Around 4,300,000 inhabitants (as of May 1939)*	3rd February, 1945	🇺🇸	• Almost 1,000 bombers escorted by 575 fighters	Around 2,894 dead
• **DRESDEN** *About 566,000 inhabitants (as of December 1944)*	13th-14th February, 1945	🇬🇧🇺🇸	• 1,300 bombers	25,000 dead
• **PFORZHEIM** *Around 79,000 inhabitants (as of May 1939)*	23rd February, 1945	🇬🇧	• 379 bombers	17,600 dead



Large cities throughout the Third Reich were targeted by Allied bombers.

Equipped with eight machine guns, the crew of a Lancaster could effectively defend itself against German fighters.

NOTES

The first major RAF bombardment of a German city. 1,468 buildings were levelled to the ground while 2,180 others were seriously damaged.

By deploying over 1,000 planes in a single raid, the RAF demonstrated that the British were now able to send a greater force against Germany than the Luftwaffe could deliver in return.

Up to one million inhabitants fled Hamburg.

City burned for seven days after the attack.

The raid's target was the city's medieval quarter because the old wooden structures would quickly ignite and create fire storms.

This raid was the Allies' single largest attack on Berlin. The destruction left 120,000 Berliners homeless.

Nearly 4,000 tonnes of bombs and fire bombs were dropped during the raid.

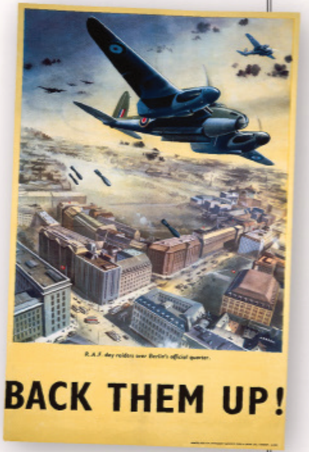
The whole city was set alight in just 22 minutes.

death awaited: "People who had fled from collapsing bunkers and had got stuck in large crowds in the streets, had burning phosphorus poured over them, rushed into the next air-raid shelter and were shot in order not to spread the flames", Wolff-Mönckeberg recounted. "In the midst of the fire and the attempts to quench it, women had their babies in the streets". The trauma was seared into memory.

"There is no proper daylight the following morning", she added, "the town is so shrouded in smoke. The sun cannot fight its way through, but looks like a bloodshot eye onto the devastation". Day felt like night and for the next three days the sun didn't reappear. The British and US continued the terror bombing for a week, and every day the number of charred corpses in Hamburg's streets rose.

The Allies finally ended their raid on 3rd August. Nazi propaganda minister Joseph Goebbels had to concede that "a city of a million inhabitants has been destroyed in a manner unparalleled in history. We are faced with problems that are almost impossible of solution". Armaments Minister Albert Speer was concerned that similar attacks against six other cities would "bring Germany's armaments production to a total halt".

Meanwhile, the surviving citizens rolled up their sleeves and began to recover the dead from bunkers and amid the rubble in addition to the thousands of bodies lying visible on the still-boiling asphalt.


R.A.F. day raiders over Berlin's official quarter.
BACK THEM UP!

Slogans on posters urged support for Bomber Command's attacks on German cities.

Life expectancy was six weeks

A total of 42,600 Germans died during the attack on Hamburg in July 1943, and almost as many were injured. At the same time, large parts of the city were ruined, and the operation was deemed a triumph in those British circles who'd not witnessed the horrors in the Hanseatic city.

Few were as excited as "Bomber" Harris, who by the end of the year was proclaiming in a letter to the Air Ministry that his bombers "should be sufficient… to produce in Germany by 1st April, 1944 a state of devastation in which surrender is inevitable".

The first months of 1944, however, clearly demonstrated Harris had been overly optimistic. In January, Bomber Command lost 2,256 crew members – a further 1,529 were lost in February, and 1,880 in March. No other military role on the Allied side was more dangerous than Bomber Command crew member, and for 20-year-old Dick Starkey, who became a pilot in Bomber Command in 1944, the first thing he heard at the air base was far from uplifting:

"Your life expectancy is six weeks. Feel free to unpack!"

Up to half of the crews in Bomber Command perished, and time between raids dragged when the men returned to barracks after their afternoon briefing.

"We'd lie on our beds and not a word would be spoken. When the

Hamburg was in chaos after air raids in July-August 1943 killed over 42,000 people.

Heavy German flak tore through Allied bombers and sent them crashing to the ground.

time came, we were like men going to the gallows", Starkey recounted. Like everyone else, the pilot feared that evening's meeting with anti-aircraft guns and night fighters, which felt like entering a battle arena. The same sentiment was felt by Squadron Leader Thompson and the rest of Z-Zebra's crew when the British flew to Nuremberg early in the morning of 31st March. The sky lit up around the Lancaster in a blur of spotlights and burning bombers that had been hit by flak and enemy fighters.

"Some blew up so close to us that the whole of our aircraft shuddered alarmingly, as if every rivet would pop out of its socket", recalled Flight Lieutenant Steve Burrows.

The large bombers could glide for three or four minutes in the air while the hull was in flames, and these fireballs in the sky helped light up the other RAF aircraft. Nevertheless, Z-Zebra managed to escape unscathed through the German defences and over Nuremberg bomb aimer Flying Officer Bill Clegg spotted the red target indicators the master bomber had dropped. On the third attempt, an ice-cool Clegg opened the bay doors, activated the trigger mechanism and dropped his bomb load over a burning Nuremberg. The crew exhaled in relief and headed home where Z-Zebra landed later that morning after almost eight exhausting and potentially deadly hours in the air.

Although many bombs had hit Nuremberg during the attack, the men thought the price had been unusually high. Burrows' suspicions were confirmed when he and his crew mates arrived at the mess: "We noticed at breakfast that many seats were empty. There were plenty of fried eggs to spare. They had been cooked for crews who never returned. That evening we consumed gallons of ale".

German morale fell in war's last year

The Nuremberg raid of March, 1944 was Bomber Command's darkest day of the war. The attack clearly demonstrated the extreme cost of bombing the enemy's heartlands. No fewer than 95 out of 795 aircraft had been downed, and 545 Bomber Command crew members lost their lives.

During the summer, however, things improved for the bomb crews, who benefited from the Allied landing in Normandy. The invasion took out many German coastal radar positions and thus their ability to detect the bombers in good time. Harris's raids became increasingly successful, and the daily bombardments gradually sucked the spirit and energy out of the German people: "Having to sit up every night, sometimes for hours, is becoming exhausting… I find the harassed faces of the people more depressing even than the desolate aspect of the town. It must be this constant insomnia that never gives one time to recuperate", wrote one Berlin woman.

"Das Bunkerleben" – bunker life – became a fixed expression among Germans in 1944-45, where the townsfolk spent a large

Crew members on the bombers wore gloves to protect against the cold at high altitude.

FACTS

HUGE LOSSES FOR BRITISH

Bomber Command had 125,000 crew members, but suffered massive losses:

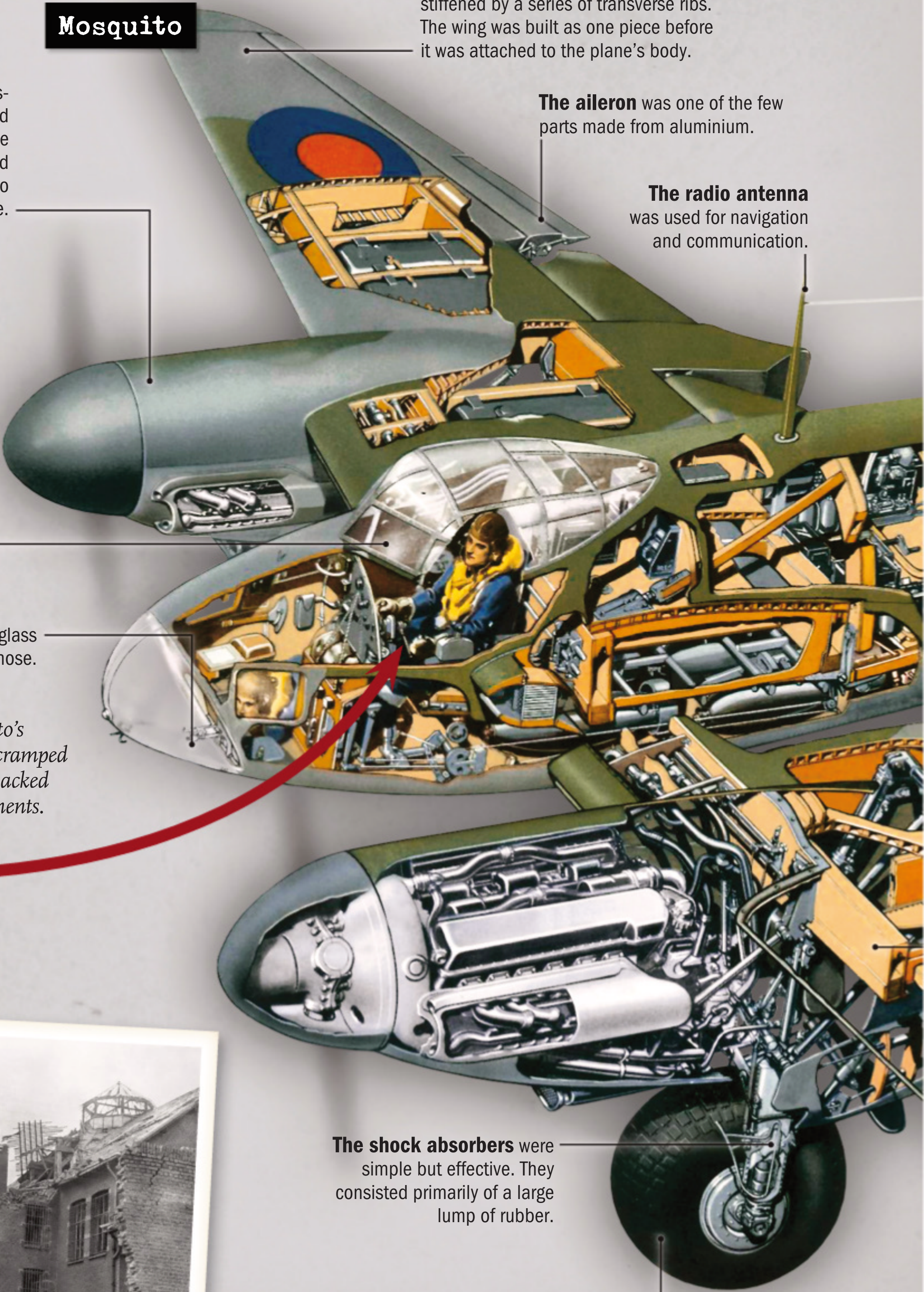
- 55,573 were killed.
- 8,403 were injured.
- 9,868 were taken prisoner.

The Nazis proudly displayed crashed Allied bombers to the public.

PLANE

Bombers were built from wooden kits

The Mosquito was basically a large-scale model aircraft. Two symmetrical halves of balsa wood and fabric were glued and screwed together before being joined to the wings. The plane was light and very fast.



The wings were made of plywood, stiffened by a series of transverse ribs. The wing was built as one piece before it was attached to the plane's body.

12-cylinder engines from Rolls-Royce, Merlin Mk 23, yielded 1,390 hp. The angle of the propeller blades could be adjusted in relation to the wind direction to optimise performance.

The aileron was one of the few parts made from aluminium.

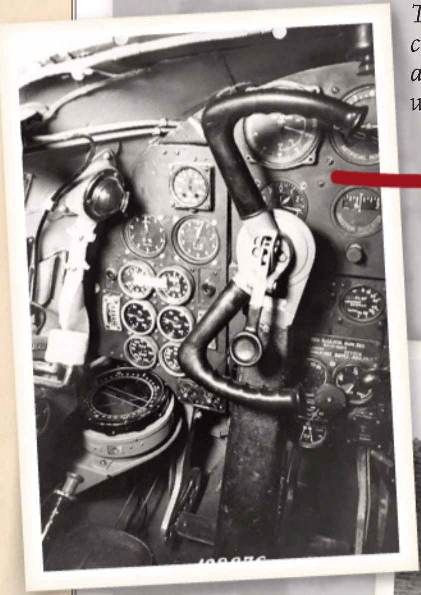
The radio antenna was used for navigation and communication.

The cockpit had room for two people: a pilot and a navigator who also triggered the bombs. The cockpit glass was also bullet proof.

The bomb aimer was placed in a glass dome in the plane's nose.

The shock absorbers were simple but effective. They consisted primarily of a large lump of rubber.

The landing gear sat right behind the engines. They could be raised and lowered by hydraulics. The wheels were fitted with a double braking system.



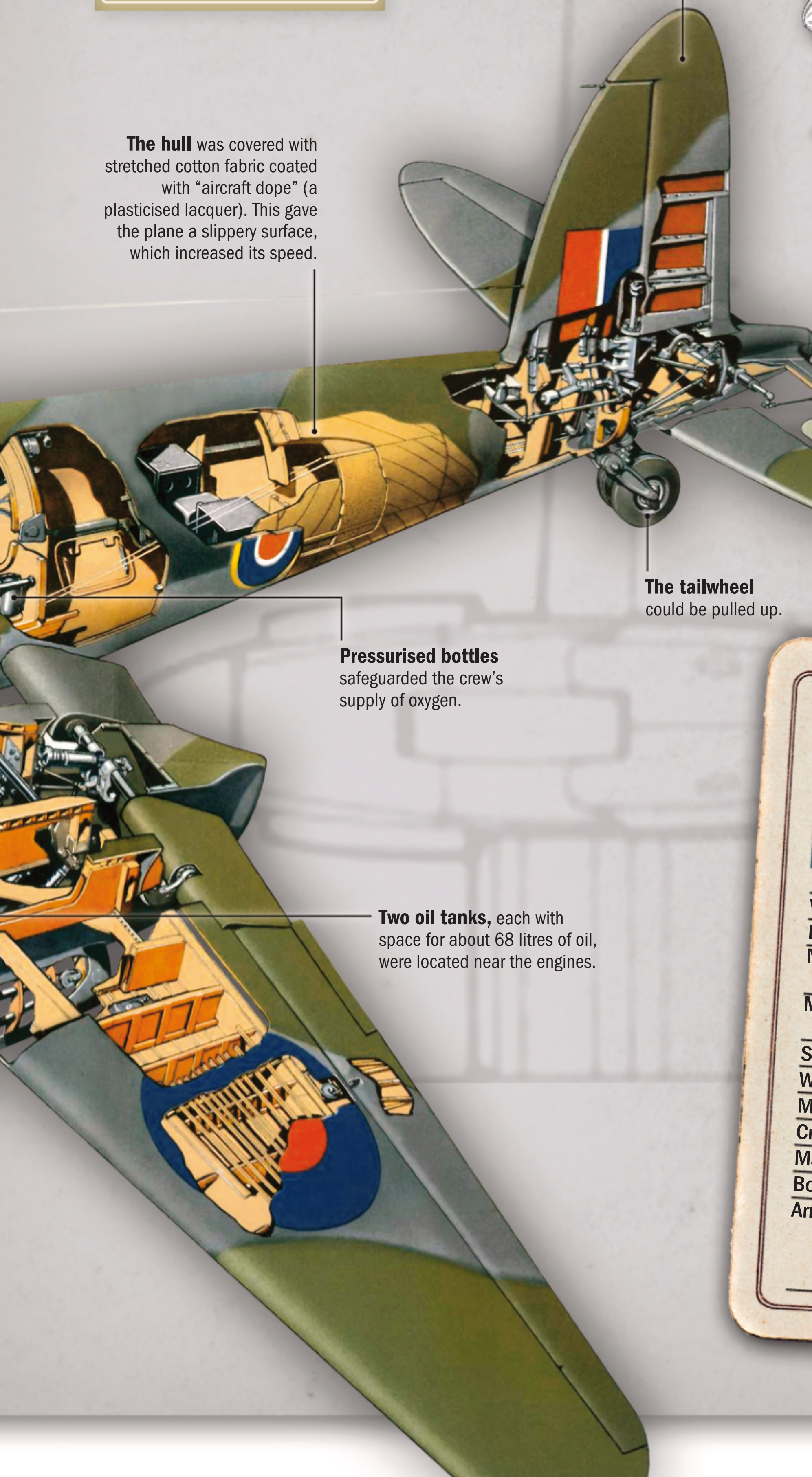
The Mosquito's cockpit was cramped and tightly packed with instruments.

Mosquitos also helped PoWs escape by precision-bombing prison camps.

FACTS

PRODUCTION

- During World War II, de Havilland factories built around 6,700 Mosquito aircraft. Most were designed as bombers.



The plane's tail was made of wood, but the surface was reinforced with aluminium and covered with fabric.

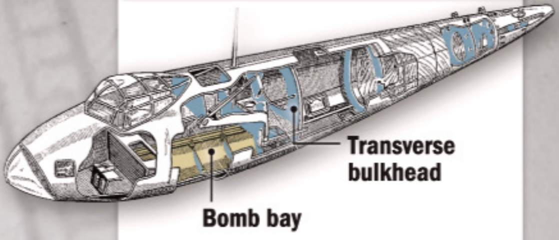
The hull was covered with stretched cotton fabric coated with "aircraft dope" (a plasticised lacquer). This gave the plane a slippery surface, which increased its speed.

The tailwheel could be pulled up.

Pressurised bottles safeguarded the crew's supply of oxygen.

Two oil tanks, each with space for about 68 litres of oil, were located near the engines.

Passenger plane



Passengers could hide in cargo spaces

The plane's body was reinforced by seven transverse wooden bulkheads. It could – in emergencies – hold a single passenger, who bent down and wore an oxygen mask while being transported in the bomb bay.

Mosquito

Wingspan	16.5 metres
Wing area	33.5 m²
Length	12.5 metres
Maximum speed	610 km/h *(at a height of 4,000 metres)*
Minimum speed	190 km/h *(without risk of stall)*
Speed at landing	225 km/h
Weight (no load)	5.9 tonnes
Maximum starting weight	10.1 tonnes
Crew	2 men
Maximum altitude	7,925 metres
Bomb load	907 kg
Armaments	4x machine guns *(7.7 mm)* 4x cannons *(20 mm)*

part of their days in concrete basements. The hardships took a mental toll as well as a physical one, as experienced by Käthe Breuer when a neighbour refused to go into the shelter.

"My husband went into their apartment and saw that the neighbour had shot himself through the temple, the gun was on the floor. He simply couldn't take any more".

The many hours people spent underground started to affect industrial production. German workers arrived tired at their assembly lines, and during the day the equipment stopped when the sirens sounded and people had to hurry to the nearest bunker. Daytime attacks, where the Allies specifically targeted factories, gradually became so feared that Germans didn't dare meet at work.

Armaments Minister Speer tried to split the factories into smaller units and camouflage the buildings so the production facilities weren't visible to enemy aircraft. This measure affected efficiency, however, and massive bombing raids on 60 of the Reich's largest towns and cities in January 1945 proved critical. Speers estimated tank production had fallen by 35 percent over the previous year, while aircraft production had dropped 31 percent. According to Speer, the enemy's increasingly successful bombing resulted in the "end of German armaments production".

Hitler Youth helped tackle the major fires after air strikes in many cities.

Residents searched for property in destroyed buildings.

CHURCHILL RECONSIDERED TERROR STRATEGY

Bomber Command and the US Air Force continued their raids on German cities until the end of the war, but "Bomber" Harris eventually ran out of major targets after leaving several of Germany's largest cities in ruins. Smaller and insignificant cities found their way on to Harris' list, but the bombardments became too much for Churchill, who wanted to rethink the strategy. In a memorandum, the Prime Minister described the bombing campaign as "mere acts of terror and wanton destruction, however impressive".

Harris joined forces with other senior staff to persuade Churchill to withdraw the reservation, and the bombings continued right up until Germany's surrender. Churchill didn't mention Bomber Command in his victory speech on VE Day, however, and Harris' men – contrary to many other soldiers – received no medals for their effort, which had taken the lives of 55,573 crew members from a total force of around 125,000.

The attacks were extremely costly for the Germans. At least 600,000 civilians were killed, more wounded and nearly eight million were made homeless. Mathilde Wolff-Mönckeberg survived the bombing and at the end of the war could walk Hamburg's streets without the constant fear of wailing sirens and falling bombs. But her homeland had been changed – in a letter to her children, Wolff-Mönckeberg concluded: "Our beautiful and proud Germany has been crushed".

NAME **SIR ARTHUR TRAVERS HARRIS**

TITLE COMMANDER-IN-CHIEF OF BOMBER COMMAND

1892-1984

Bomb chief had no regrets

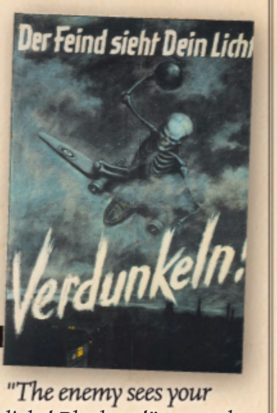
Arthur "Bomber" Harris was a veteran of both World War I and the Middle Eastern theatre of WW2, so was already a respected officer when he was appointed head of Bomber Command in February 1942. But the Briton quickly became known as a hard man who could strike fear into the toughest men simply by setting his steely gaze on them.

Harris defended the bombing strategy stoutly and never lost his conviction that he acted properly in carpet-bombing civilians in the war against the Nazis. "I would have destroyed Dresden again", was his cold-blooded answer 30 years later when a journalist asked him if it had been the right choice to bomb the city and kill several thousand civilians.

- **Died aged 91 in 1984.**
- **Memorial statue was raised after his death.**

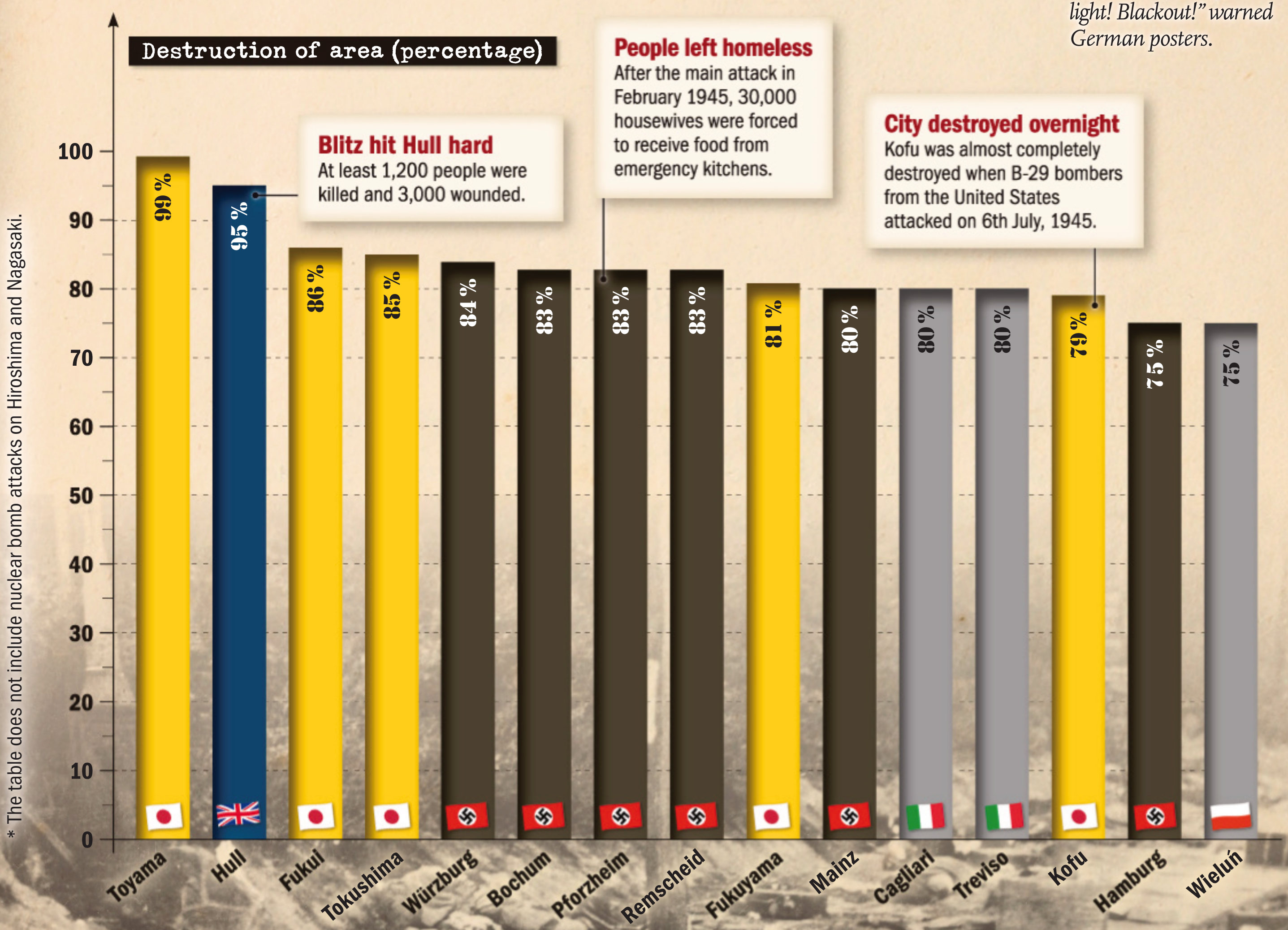
Bombings razed cities to the ground

Conventional air strikes had fatal consequences for the bomb targets. 75 percent of the area in the 15 hardest hit cities were deserted after the war. Allied bombings led the way – 13 of those cities belonged to the Axis powers.


Der Feind sieht Dein Licht
Verdunkeln!

"The enemy sees your light! Blackout!" warned German posters.

*** The war's 15 hardest-hit bombed cities**



Blitz hit Hull hard
At least 1,200 people were killed and 3,000 wounded.

People left homeless
After the main attack in February 1945, 30,000 housewives were forced to receive food from emergency kitchens.

City destroyed overnight
Kofu was almost completely destroyed when B-29 bombers from the United States attacked on 6th July, 1945.

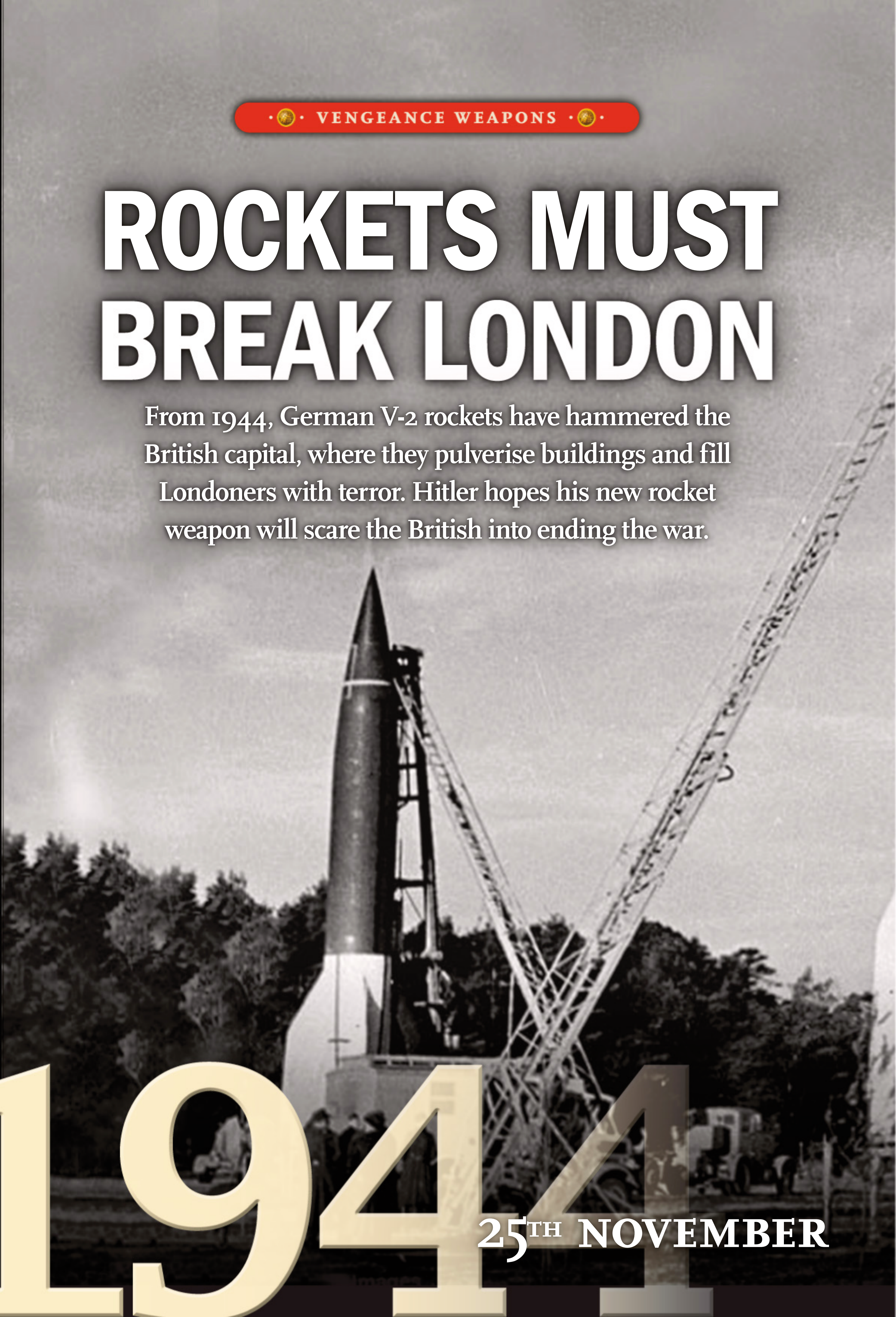
* The table does not include nuclear bomb attacks on Hiroshima and Nagasaki.

More than 4,000 of Bochum's inhabitants were killed after 150 bombings.

VENGEANCE WEAPONS

ROCKETS MUST BREAK LONDON

From 1944, German V-2 rockets have hammered the British capital, where they pulverise buildings and fill Londoners with terror. Hitler hopes his new rocket weapon will scare the British into ending the war.



1944

25TH NOVEMBER

The 14-metre-high V-2 rocket was launched from a completely vertical position and rose as high as 90 kilometres above ground level before dropping towards its target.

Germany, 1944–45

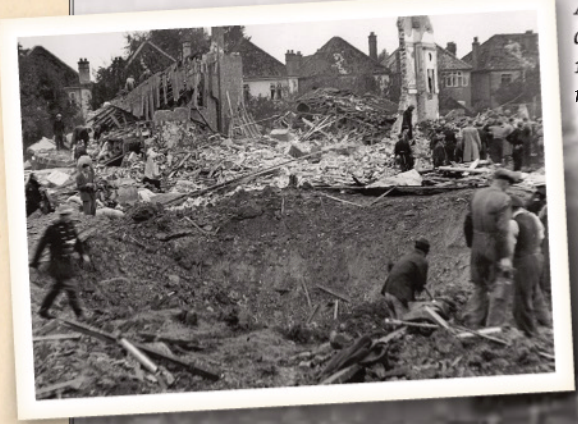
THE STAGE IS SET

Nazi researchers on a base at Peenemünde are testing a new rocket weapon for the purpose of terrorising London. When the Allies bomb the base in 1943, the Germans move it to mines in the heart of Germany. Here production continues, and in the autumn of 1944 V-2 missiles descend over the British capital.

Peenemünde
Dora
GERMANY

WITHOUT WARNING, CUSTOMERS AND EMPLOYEES in he Woolworths department store in London's New Cross were suddenly dazzled by a blinding light followed by what sounded like the crash of thunder. The whole building shook, and seconds later it collapsed. The result was terrifying – rescuers dug through the ruins to find 168 bodies.

Survivors and witnesses to the disaster on 25th November, 1944 were shocked, but had no idea what was behind the devastation: a V-2 rocket. The rocket's route from Germany had seen it briefly enter space at which point the engine ran out of fuel. The terror weapon continued its deadly mission using Earth's gravity to drive it, falling down from the sky in a curved path that ended in the middle of the packed department store. The rocket drilled its way into the building before detonating its 975-kilogram explosive charge.



A V-2 rocket left a crater approximately 10 metres deep and 15 metres wide.

Government was silent on the V-2

The British government – unlike the civilian population – recognised the Germans' new superweapon, but was nevertheless surprised. The year before, Britain had successfully bombed the V-2 base in Peenemünde on the Baltic Sea. Until a couple of weeks before the explosion in Woolworths, the country's leaders hadn't thought the Germans capable of continuing the production of the terror missiles after the attack on Peenemünde. Rocket production was now taking place in long, dark and humid underground

tunnels, where malnourished concentration-camp prisoners toiled around the clock under constant threat of execution.

Prime Minister Winston Churchill informed Parliament that the country was under attack from a brand new weapon – German rockets. They flew above the speed of sound, so nobody perceived them. The rocket's sound was only heard after impact along with the explosion.

V-2 rockets were much faster than the V-1 rocket, small unmanned jet engines, which the Germans had fired at Britain in large numbers in 1944. V-1s were slow enough that they could be shot down with some skill and luck. In contrast, V-2 missiles appeared like lightning out of a clear sky; also, they were so heavy they often drilled deep into the ground before they exploded. A V-2 typically left a crater 10-15 metres wide and 10 metres deep.

The first V-2 attack took place in early September 1944, almost three months before the Woolworths explosion, but the government had initially kept the attacks secret to avoid scaring the population. This was possible because the strikes were so random and occurred at such speed that nobody saw the missiles.

But politicians' assurances that London was no longer at risk from rocket attack – and that the war would soon be over – suddenly sounded hollow.

HITLER PERSONALLY GAVE THE ORDER

Technically the V-2 was the world's first ballistic missile that – like a cannonball – followed a curved path through the air once its fuel was exhausted. The Germans fired a total of 1,115 missiles at the British mainland, of which 517 hit the London area. During the most intense period, 60 rockets were hitting London a week. Hitler feared the V-2 would be deployed against random and secondary targets, so demanded that the shelling be concentrated on London and Antwerp. The Belgian city was hit by as many V-2s as London – it had been liberated by the Allies, and so must face reprisals. In addition, the Germans hoped to render the port unusable, but like London the missiles' targets were pure chance. Some struck without causing serious harm, while others triggered similar devastation to that suffered in New Cross. One example saw a V-2 strike a packed Rex Cinema on 16th December, 1944, killing 561 people.

For the German army, the V-2 rockets represented their final and desperate hope of reversing the war.

1912-1977

NAME **WERNHER VON BRAUN**

TITLE ROCKET ENGINEER

Book ignited V-2 inventor's interest

Wernher von Braun became interested in rockets aged 13 when he got hold of the book *The Rocket into Planetary Space*. Until that point the German had not enjoyed science, but now he eagerly threw himself into physics and mathematics, the two subjects necessary to understand rocket science. Von Braun's tenacity paid off. After studying as both physicist and engineer, he became technical director of the rocket development centre in Peenemünde.

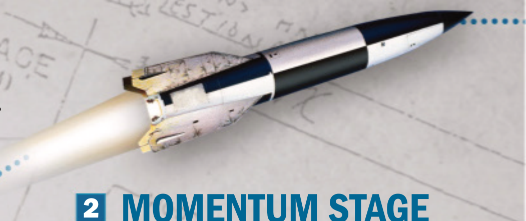
- **Surrendered to the Americans in 1945.**
- **Developed the Saturn V moon rocket.**

Civil defence members look for survivors in the ruins after a strike from a V-2 rocket in the south of England.

Rocket reached space

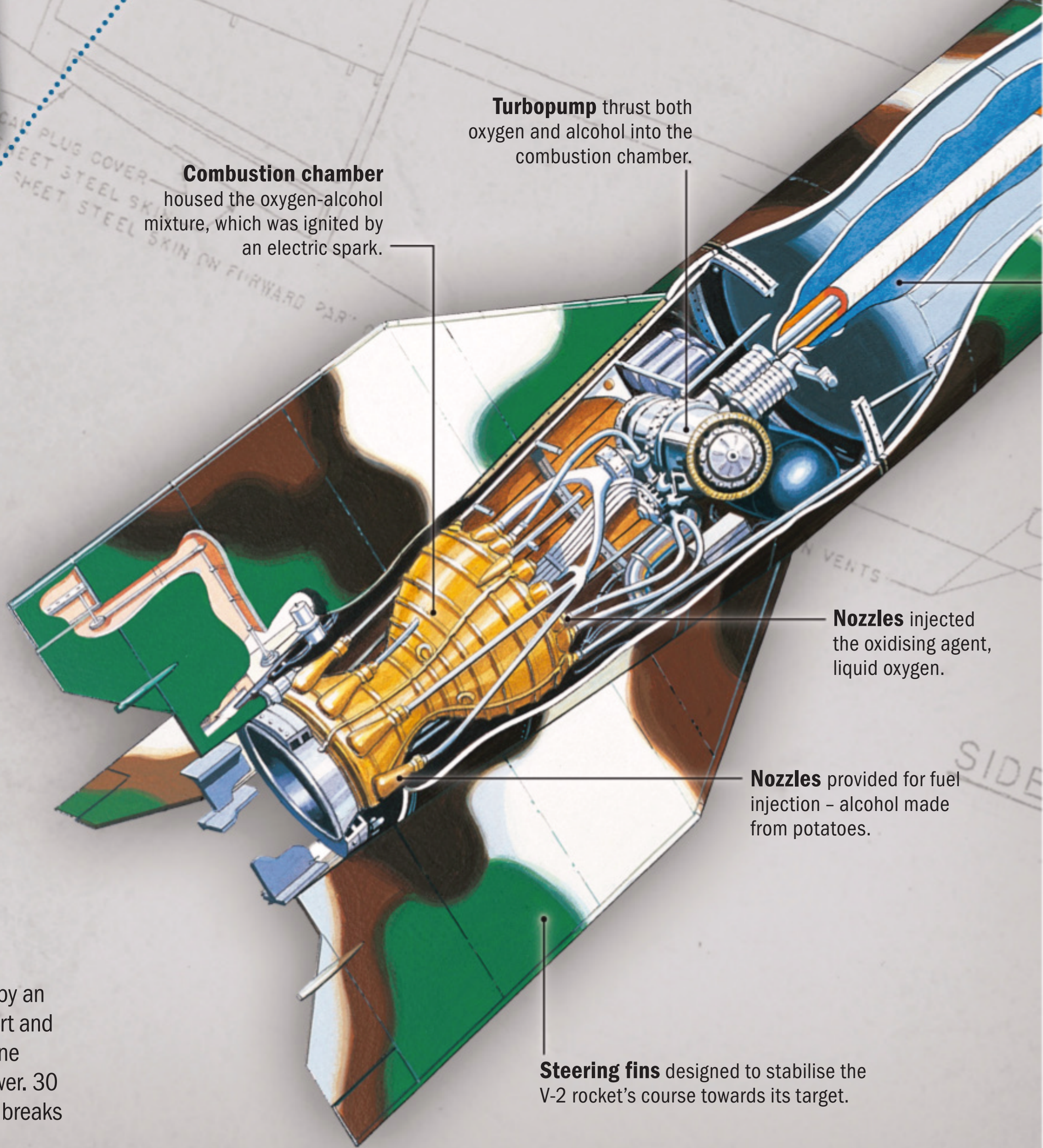
An advanced and powerful engine ensured that the V-2 rocket rose to around 90 km above the Earth's surface before diving towards its target.

During test flights, the V-2 rocket was painted with white and black fields, so the researchers could see how much it rotated.



2 MOMENTUM STAGE

The fuel is exhausted after 65-70 seconds. Its height is about 35 kilometres, and the rocket has enough speed to continue in a ballistic arc to 93.3 kilometres above the Earth's surface and thus the edge of space.



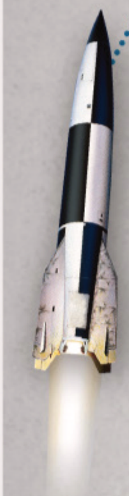
Turbopump thrust both oxygen and alcohol into the combustion chamber.

Combustion chamber housed the oxygen-alcohol mixture, which was ignited by an electric spark.

Nozzles injected the oxidising agent, liquid oxygen.

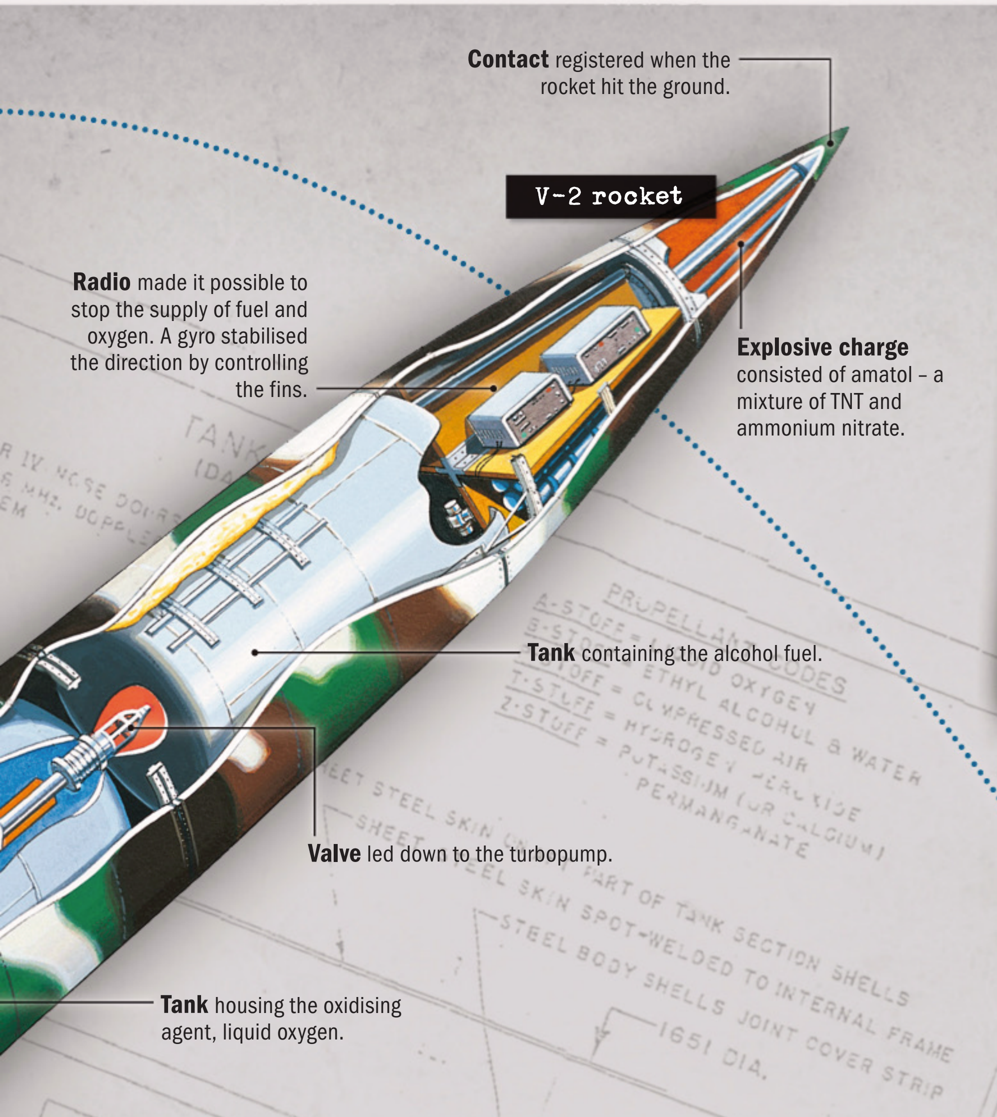
Nozzles provided for fuel injection – alcohol made from potatoes.

Steering fins designed to stabilise the V-2 rocket's course towards its target.



1 LAUNCH

Liquid alcohol flows into the combustion chamber and is lit by an electric igniter. Turbopumps start and supply additional fuel. The engine delivers 30 tonnes of lifting power. 30 seconds after lift-off the rocket breaks through the sound barrier.



Contact registered when the rocket hit the ground.

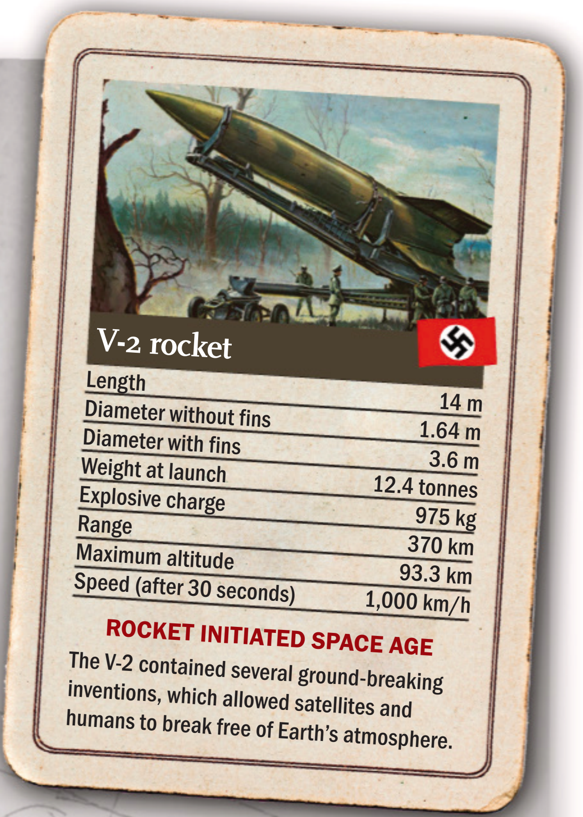
Radio made it possible to stop the supply of fuel and oxygen. A gyro stabilised the direction by controlling the fins.

Explosive charge consisted of amatol – a mixture of TNT and ammonium nitrate.

Tank containing the alcohol fuel.

Valve led down to the turbopump.

Tank housing the oxidising agent, liquid oxygen.

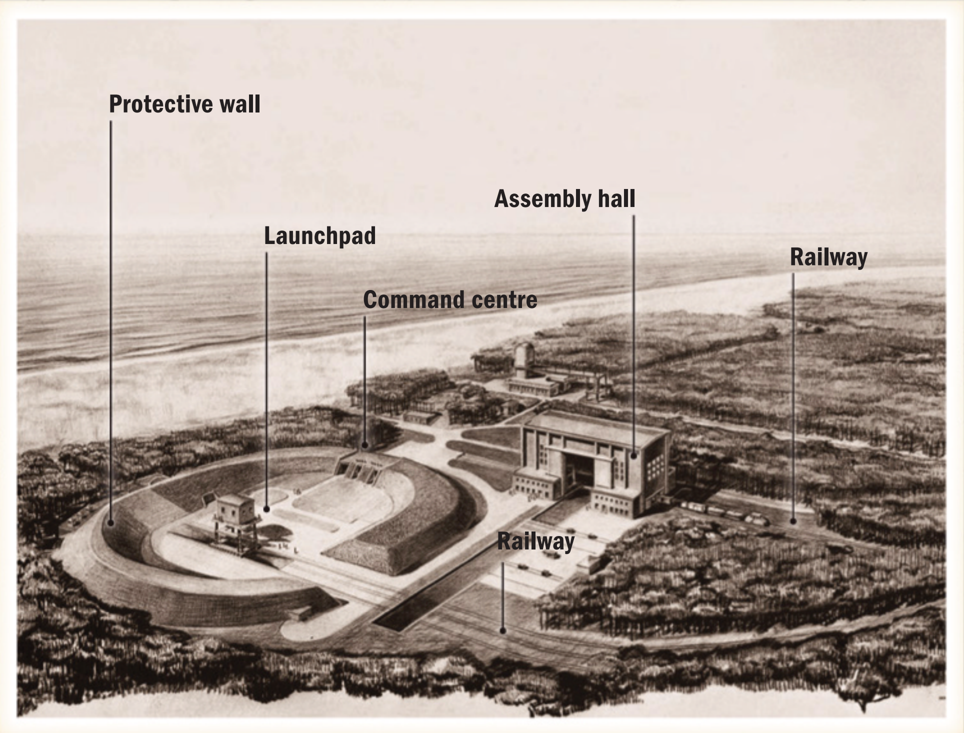


V-2 rocket

Length	14 m
Diameter without fins	1.64 m
Diameter with fins	3.6 m
Weight at launch	12.4 tonnes
Explosive charge	975 kg
Range	370 km
Maximum altitude	93.3 km
Speed (after 30 seconds)	1,000 km/h

ROCKET INITIATED SPACE AGE

The V-2 contained several ground-breaking inventions, which allowed satellites and humans to break free of Earth's atmosphere.



When a V-2 rocket was to be tested from trial area VII in Peenemünde, it was driven to the assembly hall via a railroad. Then the weapon was assembled and transported to the launchpad.

3 IMPACT

Nobody hears the rocket arrive, as it's travelling almost three times the speed of sound. At 3,350 kilometres per hour it drills into the ground and immediately explodes.

From 1943, Germans also tested V-2 rockets in Poland because the area was beyond the reach of Allied bombers.

The missiles would strike terror and fear into the civilian population because their lack of accuracy meant they couldn't be directed against military targets. German propaganda minister Joseph Goebbels named them the V-2, where the V stood for "Vergeltungswaffe", the German word for vengeance weapon. Seen through German eyes, the V-2 represented suitable revenge for the Allied bombings of Germany.

GERMAN-BUILT BASE

After the Nazis took power in 1933, its leaders made no effort to hide their fascination with modern weaponry. They weren't slow to see the potential after coming into contact with a bunch of amateurs who experimented with rockets in their spare time. Rockets represented a weapon that went even further than the most powerful artillery.

One of the most enthusiastic amateurs was Wernher von Braun. He was an engineer and physicist, and suggested the Nazis establish a base to develop and test the new weapon. Von Braun also found the right place, a deserted area near the town of Peenemünde on the German island of Usedom in the Baltic Sea. A secret base was established under von Braun's leadership in 1937 to house the rocket research project. The project grew quickly and would go on to employ numerous engineers and technicians as well as thousands of workers.

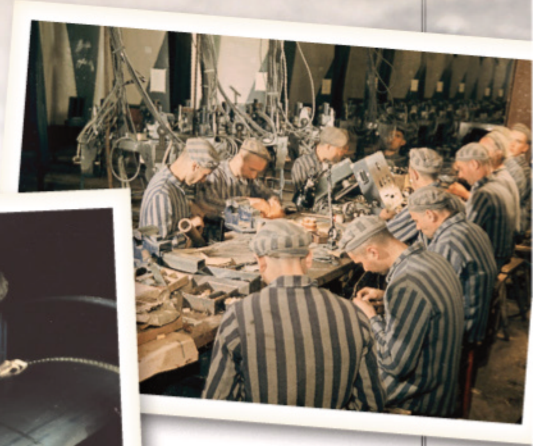
Von Braun was convinced that the future was in liquid fuel rockets. Previously, solid fuel was used, but it was heavy and not nearly as effective. On the other hand, liquid fuel was unstable, and in the first year of the base, tests effectively went from one failure to the next. Often the rockets exploded before they got into the air.

"It took us exactly one-half year to build, and one half-second to blow up", noted von Braun.

Nevertheless, the technology developed and on 3rd October, 1942 the first long-haul flight became possible when a rocket flew 190 kilometres and landed just four kilometres from its designated target. The success led to Hitler approving plans for mass production of the rocket even before the design had been perfected. Nazi leaders attached ever-increasing expectations to the V-2 as the Wehrmacht became pressed on all fronts.

For a while, the Germans managed to keep the Peenemünde base secret – despite its size. The British had already been warned of the existence of the base on 5th November, 1939, however, when an anonymous package was handed over to the British Embassy in Oslo. In the package, signed "a German scientist, who is on your side", was a detailed description of the tests in Peenemünde. The description was so astounding that

the British didn't take the intelligence seriously. But over time, more disturbing reports continued to flood in of mysterious activities on the Baltic coast, including those from Bornholm fishermen about strange flying objects in the sky. The Polish resistance movement also conveyed alarming information.



Colour images showed Hitler if the KZ-camp prisoners worked efficiently on the V-2.

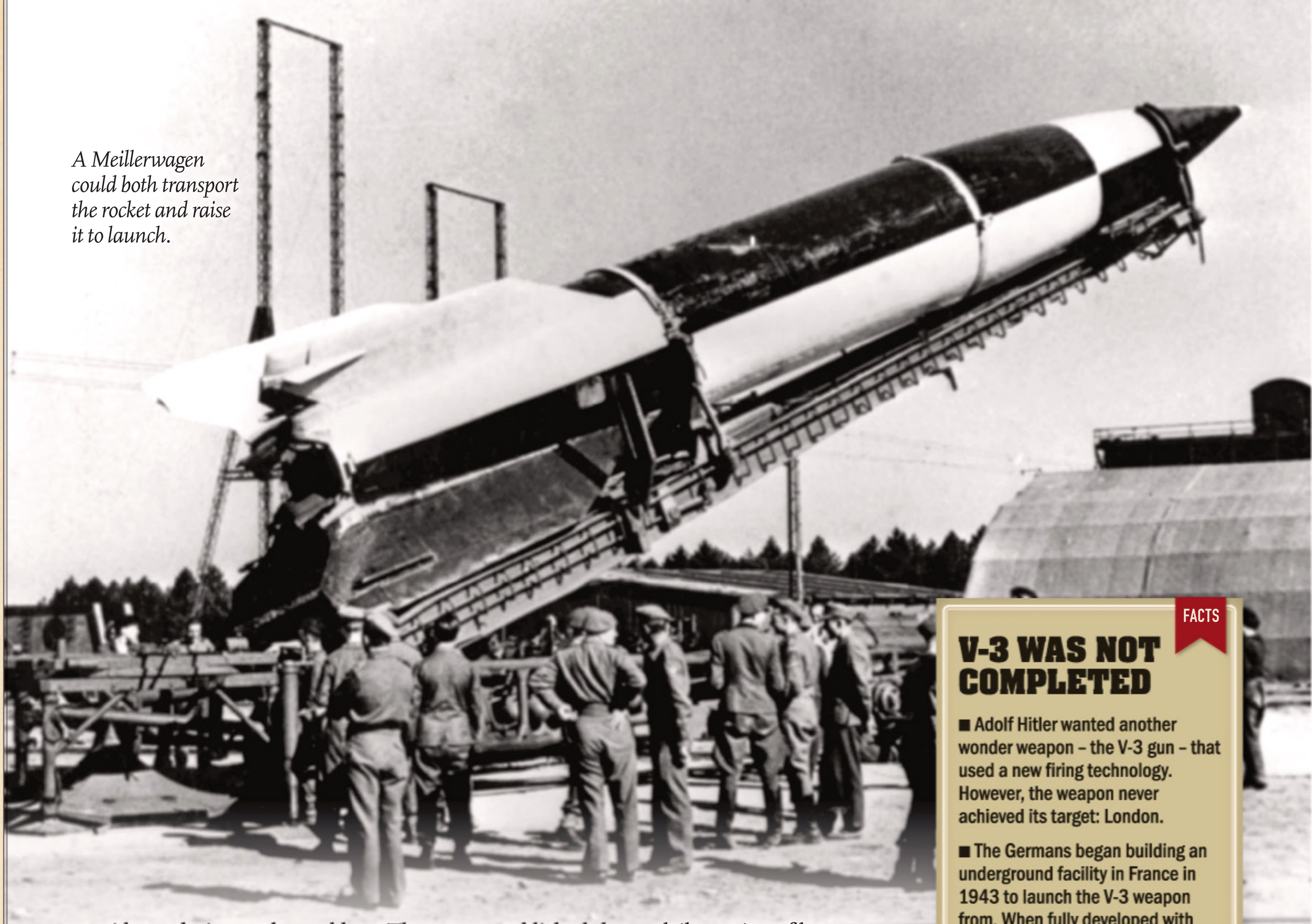
In dark tunnels and in terrible conditions, the starving prisoners produced V-2 rockets.

KZ camp was new rocket factory

In April 1943 British reconnaissance aircraft flew over the base. The pictures the planes brought home revealed with stark clarity that something was going on in Peenemünde. The British therefore decided to carry out an air raid on the rocket base. The time was set for the night of 17th-18th August, 1943 when the full moon would make it easier for Operation Hydra to be carried out.

520 bombers dropped a total of 1,875 tonnes of bombs on the base, killing 735 people, primarily Polish workers and Russian prisoners. 40 British aircraft were lost during the raid, which, despite its scale, proved only a partial success. For example, only a few of the German engineers who worked to develop the rocket were killed.

Nevertheless, the attack had far-reaching consequences. The Germans realised that the island base was far too vulnerable, and shortly after the bombing, the Nazi leadership relocated rocket production to an underground plant in the Harz Mountains in the heart of Germany. Here there were already two kilometres of tunnels dug after many years of mining. In the tunnels, an assembly line would produce 900 14-metre-long V-2 missiles a month. The government-owned company Mittelwerk was set up to be responsible for production, and orders were paid in cash, as Hitler felt the rockets were crucial for deciding the war. Mittelwerk quickly ran into major problems, however. One of the biggest was a lack of labour, but the Nazi SS was pleased to



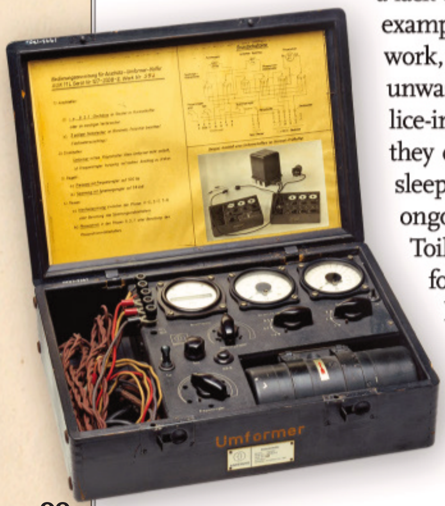
A Meillerwagen could both transport the rocket and raise it to launch.

provide a solution to the problem. The corps established the concentration camp Dora, initially as an off-shoot of the Buchenwald concentration camp, but later as an independent camp. In the dark tunnels long rows of barracks were quickly constructed, and in September 1943 the "deliveries" of labour – thousands of prisoners – began to arrive at the camp.

During the first four months, the prisoners worked to adapt the tunnels, which were to be expanded and connected by numerous cross tunnels to convert the area into a factory.

Dora soon became infamous as a hell on Earth. When new prisoners arrived, they waved goodbye to daylight. Once through the large gates they were shut away in the dark underground of the mine, where welding flames regularly lit up and the air was choked with dust.

Around the clock, the caves resounded with the sound of pneumatic hammers and explosions to expand the tunnels. The rock sides were slippery with moisture, but otherwise there was a lack of water. The prisoners couldn't, for example, wash. After 12 hours of dusty work, they would throw themselves unwashed and fully dressed on wretched lice-infested mattresses, where the best they could hope for was a few hours of sleep – disturbed by the noise of the ongoing work, including explosions. Toilets were primitive latrines in the form of cut-out oil drums with planks laid across their top. Food rations – a daily serving of beet soup, a hunk of stale bread and margarine – did not provide the energy required to sustain the prisoners.



With the help of a special electronic device, technicians could test the V-2 rocket just before firing.

One prisoner succumbed after another. Many dropped dead in the middle of work, after which the bodies were stacked in a corner and driven away once a day. Some days, 100 bodies would be transported to the Buchenwald crematorium where they were burned.

FACTS

V-3 WAS NOT COMPLETED

- Adolf Hitler wanted another wonder weapon – the V-3 gun – that used a new firing technology. However, the weapon never achieved its target: London.
- The Germans began building an underground facility in France in 1943 to launch the V-3 weapon from. When fully developed with effective shells, the facility would soon be able to destroy London.
- In July 1944, the British destroyed the plant in a bombing raid, and the Germans abandoned the project.

FÜHRER WANTED FIXED LAUNCHPADS

After four months the tunnel was ready to house the factory. In December 1943 the assembly line in the tunnel was completed, and on the last day of the year the first three V-2 missiles rolled out. All work was inspected by engineers, and the SS ensured iron discipline. If there was reason to act, the sentence was immediately carried out: death by beating or hanging. The executed – at one point as many as 200 – were placed on display over the heads of the workers. Nevertheless, forced labourers were able to hamper production through working clumsily or slowly. Ultimately German high command was left dissatisfied, both with the pace and quality of missile production, and hundreds of V-2s were scrapped. Despite the prisoners' obstructive behaviour, however, the Nazis insisted on using the Dora camp as a missile factory.

However, the quality of the rocket was not the only barrier to it being able to deliver its deadly cargo. The method of launching the V-2 led to long discussions between German officers, even before production had started in the KZ camp. Some advocated using mobile firing systems that could be hidden from the enemy, while others argued for fixed ramps that were more stable. The discussions gradually rose to the highest level, and in March 1943 Hitler decreed that large bunkers be built as close to the British mainland as possible. From here the rockets could be fired in a steady stream – particularly towards London. The first massive bunker was to be in a forest near the town of Watten in northern France, not far from the English Channel. Soon 4,000 men were engaged around the clock to cast concrete and construct the bunker, which was designed to accommodate 34 missiles and handle four firings per day.

But Allied intelligence got wind of the plans, and on 27th August, 1943, no fewer than 187 bombers were deployed. The time was chosen carefully, while much of the concrete was still wet, to ensure complete destruction of the facility.

The bombing forced the Germans to change strategy. They now chose to construct mobile installations for firing. But it made little difference. Rocket technology was not fully developed, and the first firings were a complete failure. Of the 57 missiles fired, only 26 made it into the air, and many of them exploded shortly after take-off. Even if they made it to space, many rockets exploded as they headed back towards the Earth's surface. Only seven of the 57 rockets flew roughly as planned, and only four of those hit the designated target area.

In autumn 1944 the engineers had come far enough so the first mobile firing units were ready. Each unit required 32 vehicles and trailers. Among the many pieces of equipment were tanks of liquid oxygen and trailers with pumps.

According to the crew's V-2 manual, the missiles should be treated as cautiously as eggs, yet time and again a rocket exploded during preparation or just after lift-off. Nevertheless, the strategy with the mobile devices worked from a German point of view. Even though the units were large, they could easily be hidden in places like forests, and not once did the Allies succeed in destroying a mobile device while it was preparing rockets – an operation that took around four to six hours.

But it was too late. Just six months after the first rockets rolled out of Dora, the war ended. The Nazis' dream of crushing British spirit with a new super weapon had been broken.

ALLIES TOOK MOUNTAIN TUNNELS

The first Allied troops entered the tunnels at Harz in April 1945. The soldiers could barely believe their own eyes.

"It was like being in a magician's cave," said US major William Castille when he stood in the heart of the tunnel.

Not a single soul was found in the factory. On the other hand, the assembly line appeared as if it had only been interrupted by a short break and could be resumed at any moment. Everything appeared to be in order, and several half-finished rockets hung from the ceiling. Even the ventilation was still running.

Unfortunately, there had been nothing like order when the prisoners were evacuated shortly before the Americans arrived. The SS wanted to eliminate all traces of their barbaric forced labour regimes, which had developed into brutal chaos when prisoners were killed for showing the slightest weakness. Several thousand died during the evacuations alone.

Historians estimate that at least 15,000 forced workers died as a result of producing the V-2 rocket – paradoxically, around three times more than the approximate number (5,000) who died as a result of the German rockets' attacks.

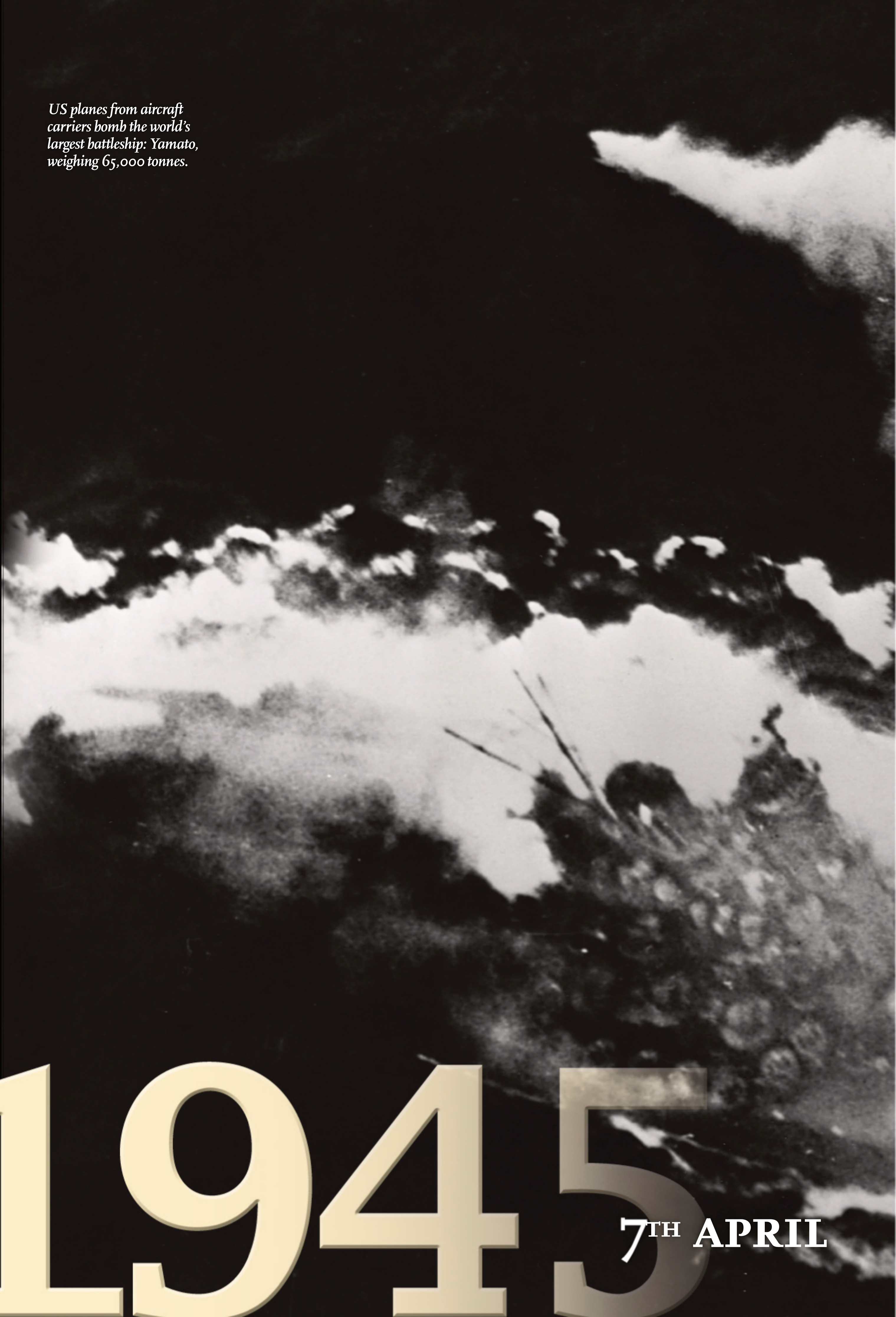
V-2 rocket was the first step to the Moon

German engineers helped the US develop rockets after the war. Their work led to the Saturn V rocket that sent the first people to the Moon in 1969.

Rocket engineer Wernher von Braun, technical director of the rocket development centre in Peenemünde and one of the most important men behind the V-2 weapon, voluntarily surrendered to US troops at the end of World War II. Von Braun persuaded 500 of his scientists to do the same, while providing test equipment and rocket plans to the Americans. The German rocket scientists were sent to the United States where they worked to develop rockets for the US Army.

In 1950, von Braun's team moved from Texas to Alabama, where they built the Jupiter ballistic missile, and 10 years later, the German engineers were transferred to the government's recently established NASA space organisation. Von Braun was appointed head of NASA's Marshall Space Flight Center and Chief Architect of the Saturn V rocket, which in 1969 launched the Apollo 11 crew to the Moon. The Saturn V comprised three fuel modules and could reach speeds of 24,000 km/h.

A Saturn V5 lifts off from the Kennedy Space Center in 1967 during the rocket's first test flight.



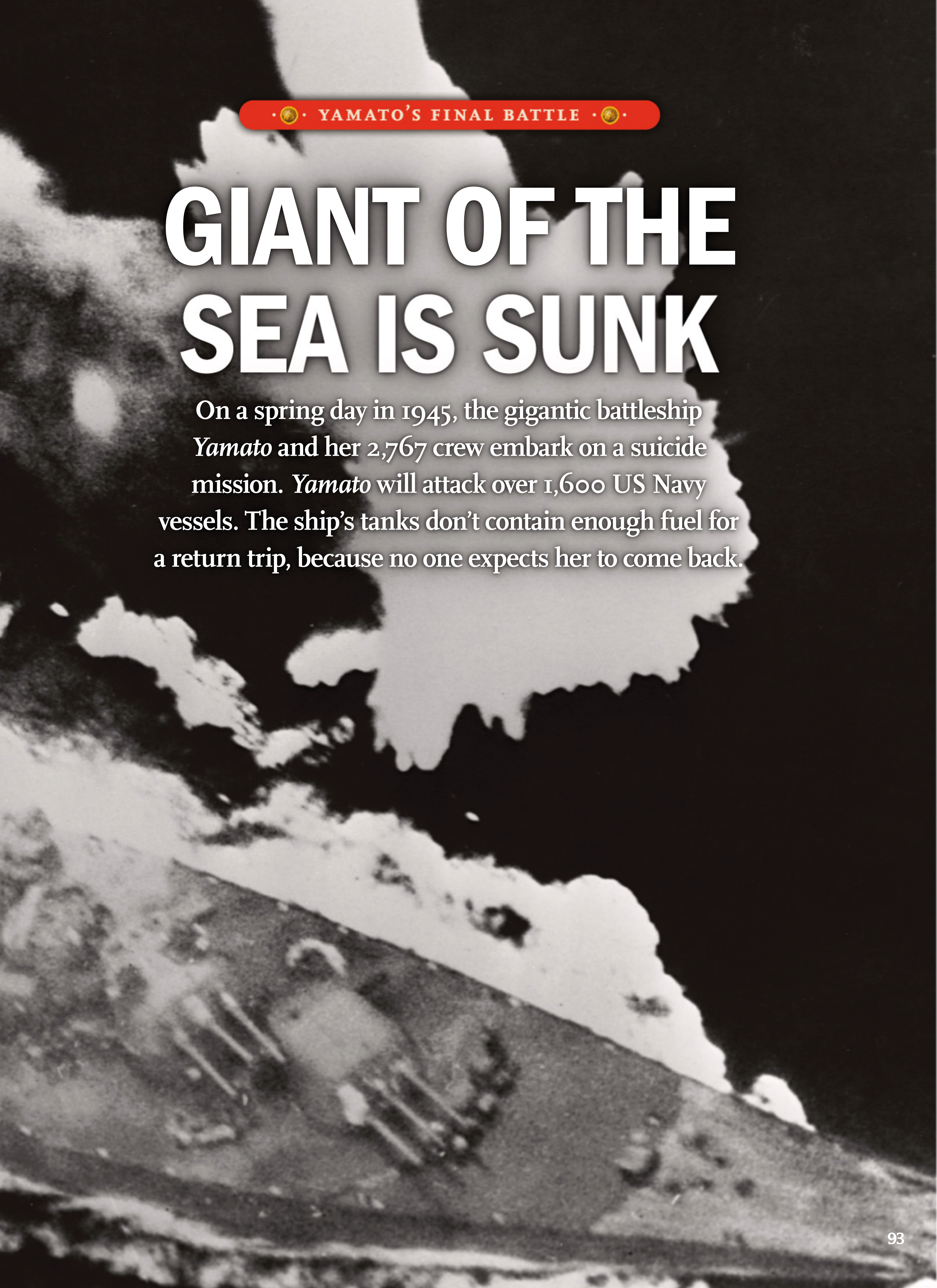
US planes from aircraft carriers bomb the world's largest battleship: Yamato, weighing 65,000 tonnes.

1945

7TH APRIL

GIANT OF THE SEA IS SUNK

On a spring day in 1945, the gigantic battleship *Yamato* and her 2,767 crew embark on a suicide mission. *Yamato* will attack over 1,600 US Navy vessels. The ship's tanks don't contain enough fuel for a return trip, because no one expects her to come back.



Japan, 1945

THE STAGE IS SET

JAPAN
Okinawa

The invasion of Okinawa is under way. If the US succeeds in taking the island just 550 kilometres from Japan, the Allies will have a forward base for launching air attacks against the Japanese mainland. In a final desperate attempt to stop the US Navy, the empire dispatches the world's largest battleship against the enemy.

19-YEAR-OLD MASANOBU KOBAYASHI knelt around a low lacquered table with his parents at their home in the Japanese port city of Kure. Outside, the noise of military vehicles and hundreds of soldiers could be heard around the harbour, but as yet neither mother nor father had touched upon their son's upcoming mission. Instead, they talked about everything at home that the young gunner would soon miss. Following tradition, his father only broached the unpleasant topic at the end of their meeting:

“About the war. The Americans still do not seem to admit defeat… There are rumours in the town that Okinawa is about to be attacked”.

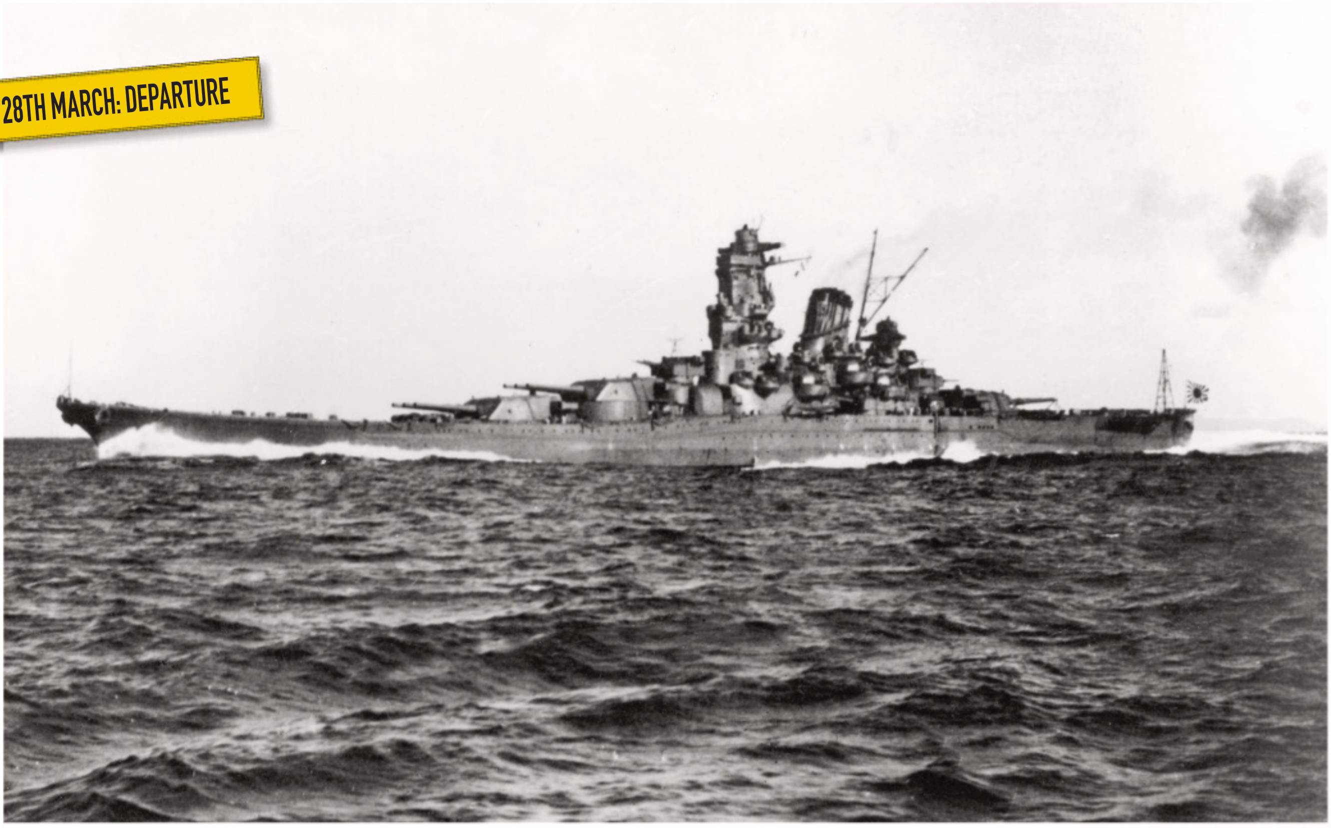
Kobayashi licked the last crumbs of his mother's cake from his fingers before answering his father, as any Japanese soldier had been taught to do: “There are always rumours… A man must be prepared to die”.

Imperial Japanese Navy officers wore caps sporting gold anchors.

For a moment, all was silent. Kobayashi wished to say more, thanking his parents for all they'd done. But instead, he rose and mumbled: “I am proud to serve on *Yamato*”. He then stepped out of the door and left.

CREW REWARDED AND PUNISHED

No one could forget *Yamato* after seeing her. She loomed above the harbour of Kure, a 65,000-tonne mass of grey steel. The Imperial Seal of Japan – a gold chrysanthemum – shone from the top of the bow. The ship's 200-plus guns were dwarfed by three huge turrets, each sporting three 46-centimetre calibre guns that made *Yamato* larger and more powerful than any other warship in the world. There



28TH MARCH: DEPARTURE

Yamato sailed to Okinawa to attack 1,600 US ships. The mission was doomed to failure from the start, and the attack was more a case of defending Japanese honour than an operation of real strategic importance.

was a hum of activity as Kobayashi embarked. The sounds from hundreds of military boots against the steel decks blended with a metallic-sounding voice that constantly barked orders over the intercom. Bottlenecks had developed on *Yamato*'s steep stairs and ladders, and everywhere young men stood and checked their weapons or watched the hubbub.

Although no-one knew the ship's destination, everyone was full of expectation as the ship's hawsers were loosed on 28th March, 1945 and *Yamato* glided majestically out of the harbour. After a hard winter, the cherry blossoms had finally emerged after two sunny, cloudless days and Kobayashi was delighted by the sight of young women who'd waved off the proud ship. Now the enemy would feel the fists of the empire, he thought.

The first days at sea were peaceful, and yet the ship still hadn't been given final orders for its intended destination. Each morning at 05.00 the young sailors were ordered on deck, where they performed calisthenics and trained with their guns. Training ended at 07.00, when breakfast was served, then followed by more drills and more work on the ship. Kobayashi usually scrubbed the deck – a gruelling task that lasted until lunchtime.

After that, more training was mixed with competitive sports, including wrestling, to sharpen the young sailors' physique, combativeness and concentration levels. That day's programme saw young sailors often interrupted by officers asking them to recite a verse in tribute to Japanese warriors:

"... duty is weightier than a mountain, while death is lighter than a feather", they would be expected to say without hesitation Any stumbling over the words would result in a slap or blow to the ribs.

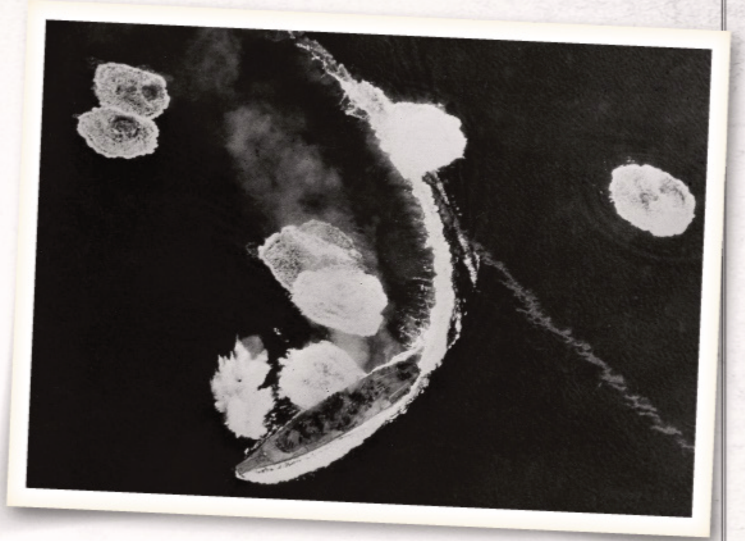
Like everyone else, Kobayashi looked forward to dinner, prepared by 18 skilled chefs. There were generous rations of sake – Japanese rice wine – that helped lift the atmosphere each evening. The conversations were free and full of optimism.

Captain received suicidal orders

Five days after sailing, *Yamato* dropped anchor on 2nd April, 1945 at the southern tip of Japan's main island, Honshu. A small fleet of warships were already on-site. The young sailors were inflamed with propaganda, but the officers knew the truth. A few years ago, an armada of frigates, destroyers and cruisers would have filled the ocean as far as the eye could see, but while the rank-and-file assumed many more imperial ships were waiting over the horizon, the officers realised that 10 ships were all that Japan could muster. Most of these were worn out or damaged by the war.

The small fleet waited two days for further orders. *Yamato*'s commander Vice Admiral Seiichi Ito was resting in his cabin after an early breakfast when he received a sealed envelope from Japanese high command. Ito took the envelope and put on his reading glasses before breaking the seal. He read the message twice and then immediately summoned his deputy, Rear Admiral Nobii Morishita.

The orders for Ito and the sad remnants of Japan's navy were merciless. With virtually no ships and despite Okinawa's inevitable fall, the military leadership had chosen to place everything on the line and continue to be guided by ancient concepts of honour and samurai tradition. Surrender was simply unthinkable. The order fell after heavy pressure from Emperor Hirohito and fanatical staff officer Shigenori Kami who blasted desperate military leaders with a tirade about death and honour: "A true samurai doesn't ask whether his efforts pay off. He's not a Kanto merchant. He merely seeks the opportunity to sacrifice himself", he shouted during the crucial meeting on *Yamato*'s future.



Sharp manoeuvring allowed Yamato to avoid an air strike in the Japanese Seto Inland Sea on 19th March, 1945.

The plan was as simple as it was crazy: without air support or enough fuel to return home, *Yamato* and the other nine warships would sail full speed right into the enemy fleet. Here they'd fight to the last man at Okinawa, land the surviving sailors on the island and attempt to kill as many of the enemy as possible.

The plan was heavily reliant on the gods, because the Japanese knew the sea around Okinawa would house an enemy fleet of no fewer than 1,600 ships, including

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Battleship broke in two

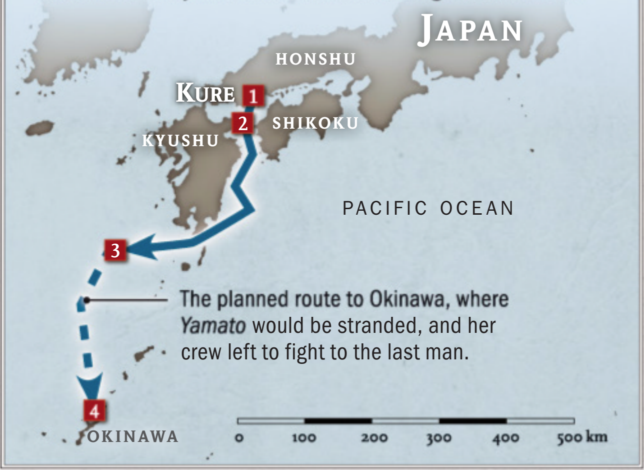
The pride of the Japanese fleet never reached her target of Okinawa before sinking – despite her enormous strength.

1 Departure, 28th March, 1945: 2,767 men wave goodbye to family and friends at the fleet base in Kure.

2 Reconnaissance, 6th April, 1945: *Yamato* receives the order for a suicide mission. Fuel tanks are only partially filled.

3 Shipwrecked, 7th April, 1945: 360 US aircraft attack *Yamato*. The battleship explodes and splits into two.

4 Goal: *Yamato's* target was both the island of Okinawa and the US Navy there. The order was to fight to the death.



The planned route to Okinawa, where *Yamato* would be stranded, and her crew left to fight to the last man.

40 aircraft carriers, 18 battleships, 32 cruisers and 200 destroyers. The operation was basically a suicide mission, and Vice Admiral Ito knew it. Over the following hours he briefed the commanders on the other ships.

"The high command has been blundering now for many months. Why must we, who have been through so many battles, blindly follow a bunch of inept, inexperienced leaders?" one of the captains thundered.

The dissension was unprecedented for Japanese captains who were usually so orthodox, but eventually Ito brought it to a halt: "Gentlemen, we are being offered the chance to die. I have no regrets and am leaving willingly".

Thus, the case was settled. Sake was poured, and toasts were drunk.

Many broke out in jubilation

The atmosphere was markedly different as the ship's men stood in row after row on the deck. There was jubilation as the men learned of their mission. Most had seen their hometowns bombed and there was a strong desire for reprisals: "Let *Yamato* strike the enemy like a Kamikaze!" an officer shouted, before hundreds of sailors spontaneously broke into the Japanese national anthem.

"Great news", one of Kobayashi's comrades cried as they tumbled back to their mess deck.

Kobayashi nodded excitedly and imagined how he'd soon have the enemy in his sights.

"Rat-a-tat-tat, rat-a-tat-tat", stuttered another, and soon the young sailors were playfully imagining the attack and landing on Okinawa.

One asked the awkward question: how would they land without weapons?

"Just take a weapon off a dead American", explained another, and his comment sparked more enthusiasm.

"One salvo from our main battery can wipe out a whole division. How many divisions have the Americans got? Five, six? Boom! Boom! Boom!"

"How many torpedoes do you reckon we can absorb?" an ensign asked suddenly.

Certainty was replaced by more sceptical voices, and as the hours passed, doubt spread through the crew of *Yamato*. Nobody knew with any certainty how much air support *Yamato* would have, and nobody had any idea of the enemy's strength.

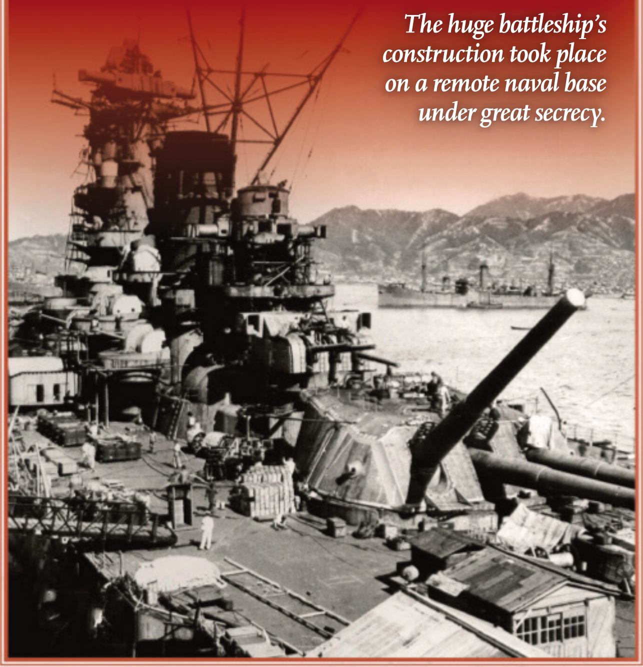
Preparation was sped up

***Yamato* was built in secret so that the US would not know of the battleship's existence.**

When *Yamato* was launched from the naval base in Kure south of Hiroshima, it happened amid quiet ceremony, so the enemy wouldn't get wind of the new ship.

Her last apparatus was installed in haste to ensure the battleship was ready for the war. Construction began in 1937 at the Kure yard, and *Yamato* underwent tests at sea in October and November 1941, where the ship attained a top speed of 27 knots. On 16th December, just nine days after the attack on Pearl Harbor, *Yamato* was fully equipped and added to the Imperial Navy.

A single sister ship in the Yamato class, *Musashi*, was inserted into the war on 5th August, 1942, while a third sister, *Shinano*, was hastily rebuilt as an aircraft carrier.


The huge battleship's construction took place on a remote naval base under great secrecy.

Commander wrote farewell letter

On the morning of 6th April, the 10 ships laid off the oil depot at Tokuyama on Honshu's southern tip for a final refill before heading to Okinawa. The depot was virtually empty, and the order specifically stated that the ships would only be fuelled for a one-way trip to Okinawa, 500 miles south. No one dared to mention the return trip.

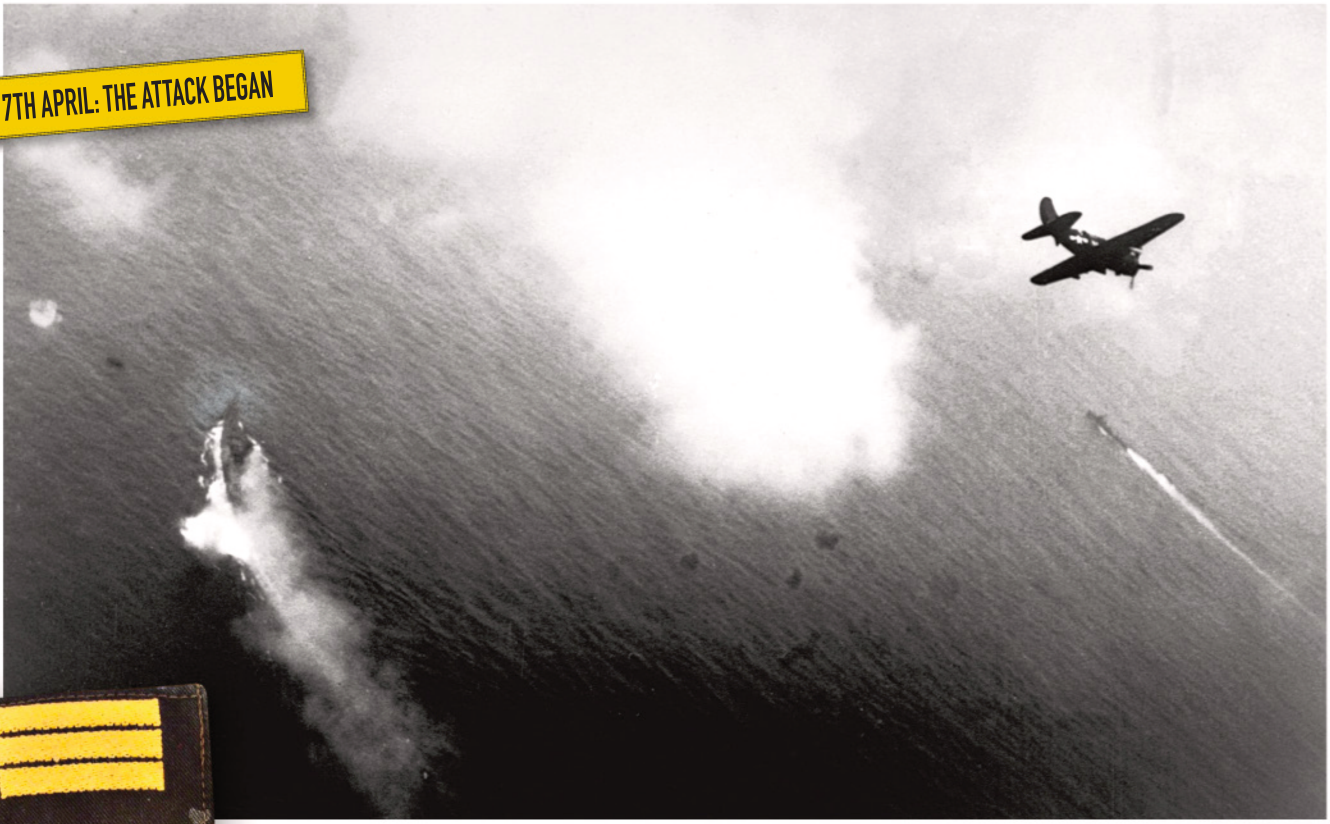
As the last drops of fuel were being poured into *Yamato*, Vice Admiral Ito prepared himself for death. He left the other officers to sit in his cabin. He was annoyed at the haste in which the decision to proceed was made, but accepted his destiny. Alone in his cabin he chose to compose a letter of farewell to his wife, 43-year-old Chitose, with whom he'd shared almost 23 years of happiness:

"To my wife Chitose... I must take this opportunity to say that the life we have shared was full of happiness. But the time has now come for me, as a naval officer, to prepare to meet my end... I know that you will have difficult and lonely times but to make it easier for you, understand that I believe in what I am doing and that in my last moments I shall be happy. From the deepest part of my heart I am praying for your happiness... Seiichi".

Ito then ordered *Yamato* to weigh anchor and set course for Okinawa. The sun was just going down as the ships passed Honshu's southernmost point, and the sailors gathered on deck for a last glimpse of their motherland. The mountainside was pink with cherry blossom and thin clouds passed over the setting sun.

Kobayashi tossed and turned in his bunk and wondered what tomorrow would bring. He was sure that *Yamato* would cope, but how would he perform? Perhaps he'd get to shoot down his first plane – maybe even several. Finally, Kobayashi fell asleep to the thundering sound of *Yamato*'s engines straining at full power.

On the deck high above, rain had begun to fall from the night sky. Rain showers were welcome as poor visibility would make



Yamato was built for naval battle with other battleships. With no air support, the fleet was at the mercy of enemy aircraft, and despite the ship's powerful anti-aircraft artillery she was easy prey for US planes.

Shoulder badge of a commander in the Japanese Navy.

it harder for the enemy to launch air attacks. Sentries stood like dark silhouettes against the railing, their heads hidden beneath their green raincoats. The wait was excruciating, but finally the horizon brightened, and the ship burst into life as hundreds of sailors swarmed on to deck. Then suddenly from high above came the sound of five Japanese Zero fighters. The Zeroes circled the small fleet three times while all the sailors cheered and waved.

All this talk about sinking! They were getting air support! They continued to cheer as the five planes disappeared.

The blood bath began

It was 13.30 when the crew suddenly spotted enemy planes far away among the rain clouds. The alarm sounded and the gunners readied themselves to defend the ships. 19-year-old Kobayashi could barely believe his own eyes. Did the enemy planes really look that peaceful? They floated like dots and moved only slowly. Kobayashi felt no fear as he tried to capture the small planes in his gun's sights. After all, he was on board *Yamato*, the world's largest battleship and pride of Japan, protected by 21,000 tonnes of armour and over 200 guns. The waves were heavy, but *Yamato* sailed full speed towards the enemy – eager to show her worth. Kobayashi had removed his helmet and flak jacket to allow for free movement but was barely in his seat when he got a shock.

A screaming sound filled the air from directly over his head. At an angle of almost 90 degrees, an American Helldiver seemed to fall out of the sky and dropped a 1,000-pound (450 kg) armour-piercing bomb directly into the ship's path. Seconds later it smashed into *Yamato*, brushing one of the towers and taking out two 25-mm guns before powering through the deck to explode two decks below. The noise had barely died away when a second 1,000 pounder was dropped. This hit the radar room, which exploded in a crash. Metal splinters flew through the air and the deck was engulfed in smoke and flames.

By now, the tiny dots on the horizon had grown big, and while survivors tried to hurl themselves behind cover, machine gun bullets rained across the deck, fired by a swarm of US Wildcat fighters. Sailors were blown off the ship like paper dolls, while blood and chunks of flesh spread over the deck.

Yamato swung violently during the many attacks, as the temperature in the ammunition depots rose dangerously. As sailors ran down into the ship to avert disaster, the situation was only getting worse. Several torpedoes slammed into *Yamato*'s port side and for a moment the entire

1890-1945

NAME **SEIICHI ITO**

TITLE VICE ADMIRAL

Admiral wanted peace with the US

Seiichi Ito joined the Imperial Japanese Naval Academy as a cadet in 1911. He advanced rapidly after graduation, and in 1923 obtained a degree from the navy's academy for officers.

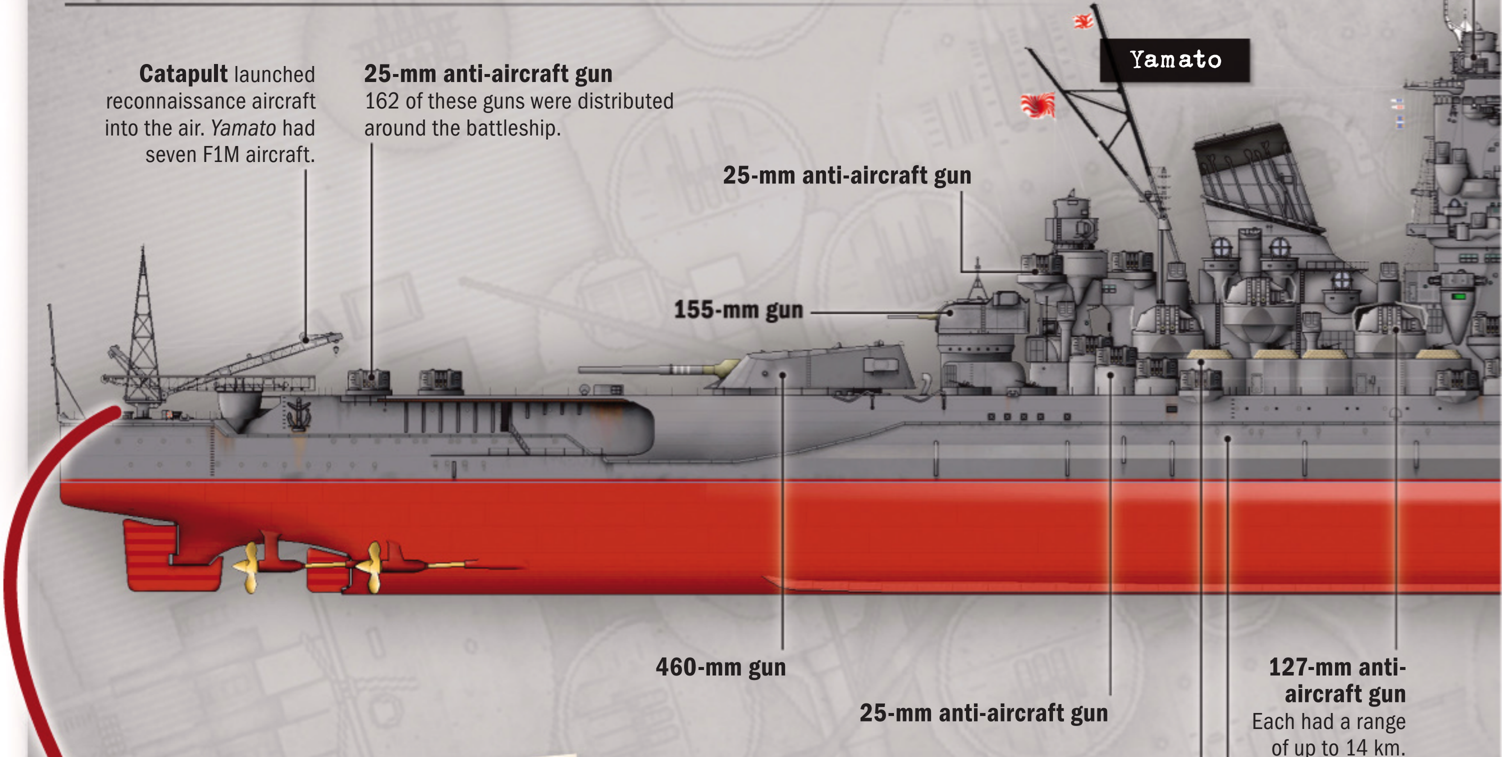
Ito travelled in the US in 1927 and became an advocate for peaceful relations when he recognised the US's major industrial capabilities. From 1932-33 Ito was also briefly naval attaché to Manchukuo, the Japanese puppet state in Manchuria, China.

- **Visited the US in the 1920s.**
- **Was naval attaché in Manchukuo.**

WARSHIP

Battleship was world's heaviest

Yamato was designed so that the vessel could fight multiple enemies simultaneously. Powerful guns were placed both in front of and behind the command bridge.



Catapult launched reconnaissance aircraft into the air. *Yamato* had seven F1M aircraft.

25-mm anti-aircraft gun
162 of these guns were distributed around the battleship.

25-mm anti-aircraft gun

155-mm gun

460-mm gun

25-mm anti-aircraft gun

127-mm anti-aircraft gun
Each had a range of up to 14 km.

13-mm anti-aircraft gun
Four placed around the ship.

Armour plating was up to 340 mm thick and could withstand a 460-mm, 1,460 kg shell.

The F1M reconnaissance plane was launched by catapult. After returning from its mission, the plane landed on the water, after which it was hoisted back on the ship by crane.

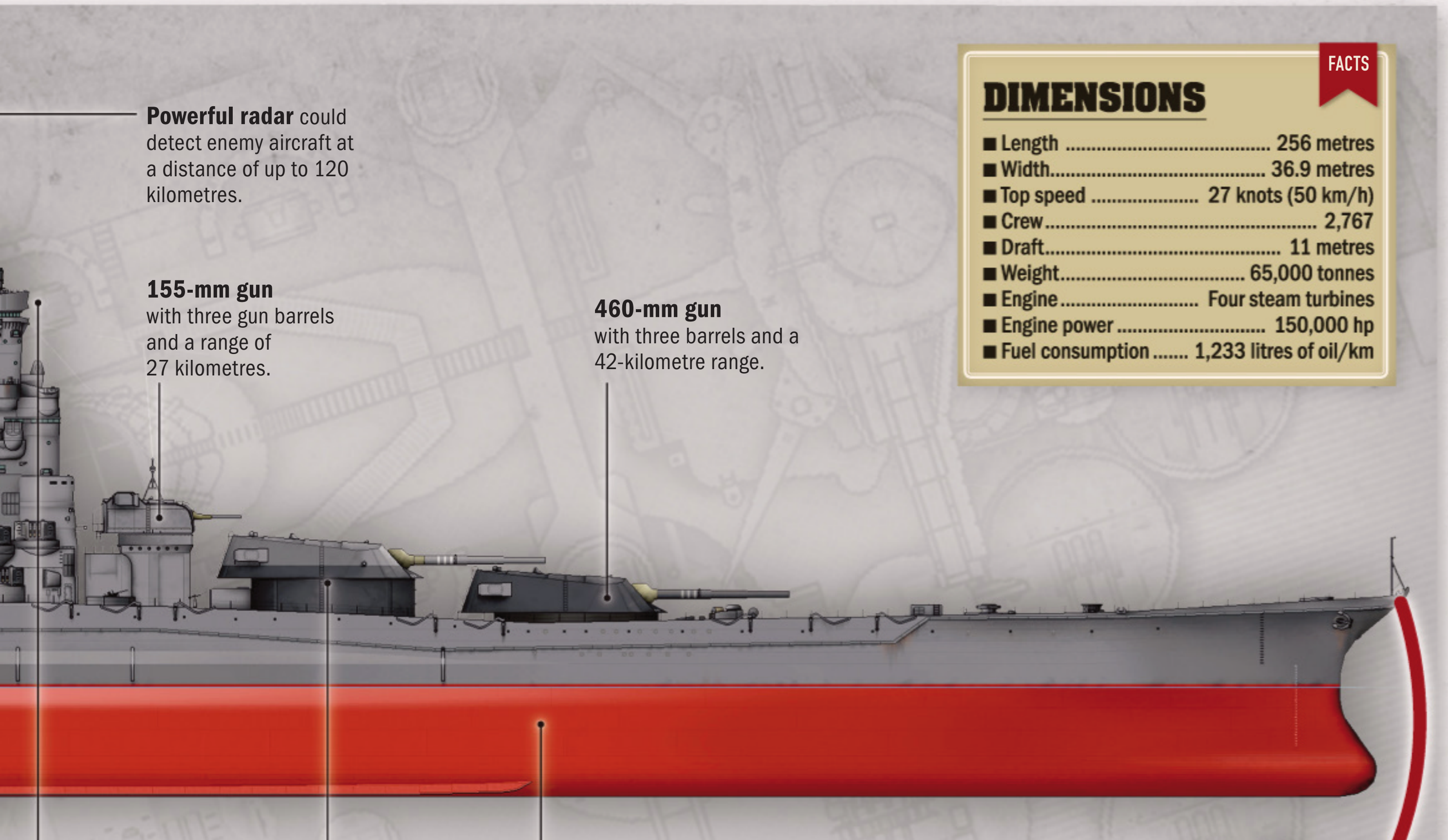
ship rose up out of the waves. An advanced system of bulkheads in *Yamato* prevented water from flushing through the entire hull, but the ship was becoming unstable. *Yamato* had started to lean dangerously.

DEAD WERE PILED INTO SWIMMING POOL

Kobayashi was blown away by the bombs' pressure wave, but miraculously escaped with his life. He crawled back to his post and settled into position as another Helldiver dived towards the ship. The plane's bombs missed their target, and as the Helldiver angled to fly away, it left its grey-white belly exposed, which Kobayashi and his surviving comrades shot at furiously. After several salvos, the plane revealed a tail of smoke, shortly followed by three yellow parachutes unfolding. The gunners yelled with joy – they couldn't be sure which shot had hit the plane, but it felt good to see the enemy downed when they were in the middle of a hail of bombs. But as they celebrated, another bomb hit, and one of Kobayashi's comrades was hurled from his gun. He lay between empty canisters with a large hole in his chest.

The planes dove so close to the ship that Kobayashi could see the faces of the pilots in their cockpits. Their aviator glasses glinted in the daylight, and he could see their white teeth with the lips pulled back either in anger or a grin as they aimed to destroy their enemy. Suddenly the teenage gunner felt a stinging pain in his forehead as his eyes filled with blood. A piece of metal 15 centimetres long had lodged in his eyebrows. He pulled it out and regarded his friend who was dying in front of him. An artery had been cut and he was bleeding to death, so Kobayashi dragged him below deck in an attempt to find help. The ship was filled with dying and wounded men, however. Some were throwing up; others screaming for help.

"Get back to your gun, soldier. This man's dead. Drop him out there", an officer shouted as he watched Kobayashi. The officer pointed towards the bathhouse, and Kobayashi pulled


Powerful radar could detect enemy aircraft at a distance of up to 120 kilometres.
155-mm gun with three gun barrels and a range of 27 kilometres.
460-mm gun with three barrels and a 42-kilometre range.
Command bridge, from where the battle was led by *Yamato's* officers.
460-mm gun
The hull was designed to help make the ship move faster. 50 designs were tested in the navy's experimental tank in Tokyo.

FACTS

DIMENSIONS

■ Length	256 metres
■ Width	36.9 metres
■ Top speed	27 knots (50 km/h)
■ Crew	2,767
■ Draft	11 metres
■ Weight	65,000 tonnes
■ Engine	Four steam turbines
■ Engine power	150,000 hp
■ Fuel consumption	1,233 litres of oil/km

A single chrysanthemum adorned the ship's bow. The flower was the Imperial Seal of Japan.

his friend into the warm waters where both had enjoyed life just a few days previously. Now dozens of dead comrades floated in the large pool.

Kobayashi returned to his post and was almost instantly struck by another piece of metal. This time it got him in the knee and the blood flowed as he pulled it out. He tried to staunch the flow with the dressing from his facial wound but felt dizzy. The ship appeared to be leaning more and more, and then suddenly he realised it was deathly quiet. No shots, bombs or aeroplane noises filled the air.

It was enough of a break for the young gunner to have a cigarette. His hands shook as he smoked, wondering if the American fighting spirit had been broken. If *Yamato* could stay afloat for just a few more hours, then repairs could be attempted under cover of darkness. But nothing around him gave Kobayashi cause for hope. Some tried to get their guns working again, others fought to gain control of the ship and stop her listing. Most were injured and bleeding, and their work was in vain. The silence only lasted 15 minutes before Kobayashi heard a fresh wave of Helldivers, and once again bombs rained down over the dying ship.

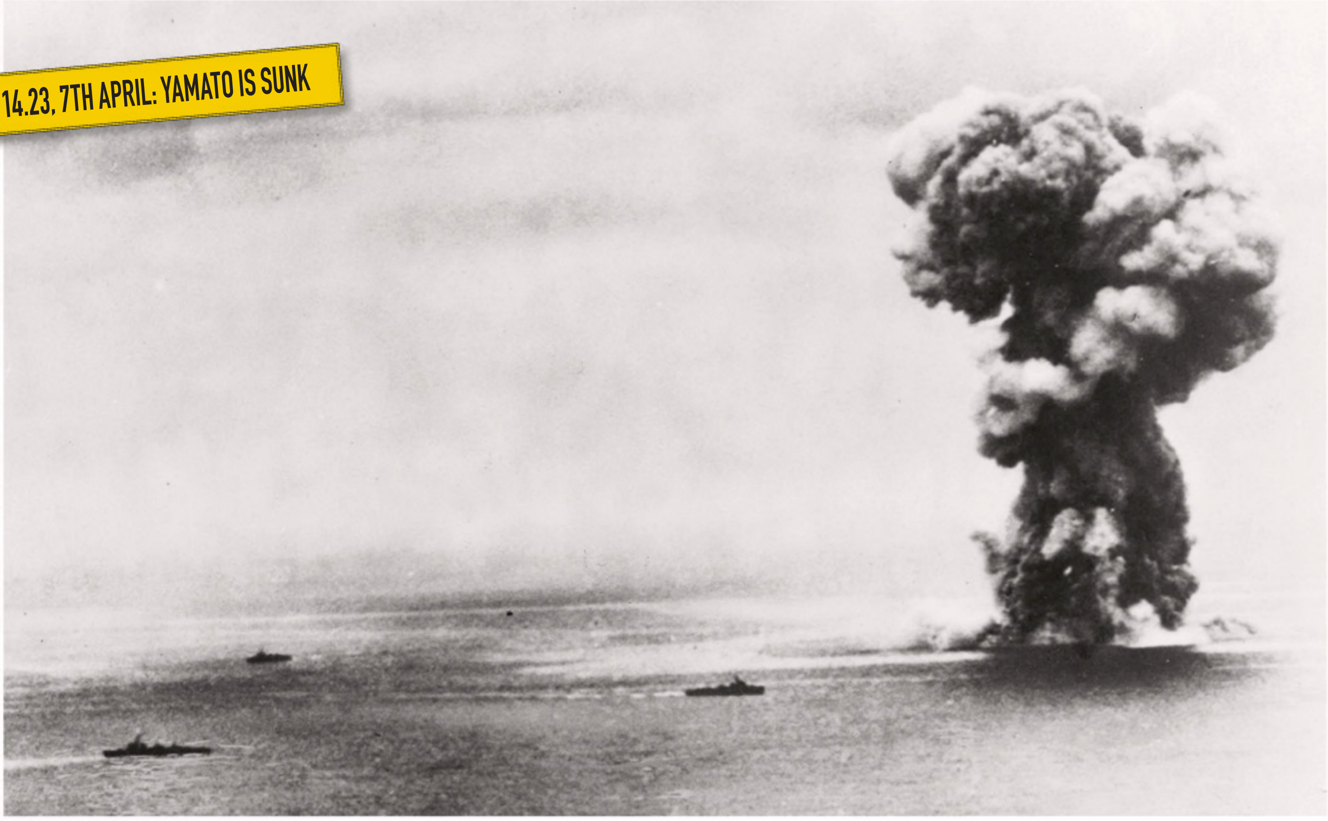
The Americans targeted most of their torpedoes on the port side, and soon *Yamato* could resist no more. The five-degree list increased to 10, then 15 and then 20 degrees, and at 14.20 a second torpedo hit. The rudder locked, all power was lost and the gun turrets jammed. The bridge had lost control of the helm, and the ship revolved helplessly around herself. The smoke and fire from the other Japanese ships was visible on the horizon.

"The emperor's portrait! Save His Imperial Majesty's portrait", an officer shouted desperately, and shortly after came the fateful message: "Abandon ship! Get out! Save yourselves!"

YAMATO FINALLY SANK

No one believed it was possible to sink *Yamato*, so there were no lifeboats aboard. Kobayashi tried to cling on to the deck as the ship's list worsened. What must it feel like to drown, he thought? He'd been told it lasted three minutes – once your lungs filled with water, you lost consciousness and slid away.

He desperately began to climb up the deck as the ship tilted further. People, equipment and guns slid down and disappeared into the dark waters as Kobayashi fought his way along the ship's side. Crustaceans that lived



Yamato capsized after being hit by 10 torpedoes and 23 bombs from American aircraft. The smoke cloud from the explosion in the ship's munitions store could be seen 120 kilometres away on the island of Kyushu. The crews of three Japanese destroyers looked on, helpless.

under the hull's waterline ripped his knees and hands to shreds as he fought his way up. Around him people were disappearing into the waves – some sung the national anthem while others screamed. A huge explosion suddenly hurled him through the air and he landed in the ocean. He heard his mother call him as the water closed over his head, and he lost consciousness.

Yamato – the world's largest warship – had finally gone down in a huge explosion after a hopeless battle of 102 minutes. A mushroom-shaped cloud rose hundreds of metres above sea level, and desperate Japanese sailors grabbed at anything that still floated. The ocean's surface was covered with a sticky oil, and even though the ship had gone, the enemy still took pot shots at the heads of those desperately trying to stay afloat in the waves. Only after a gentle rain had set in did the last planes leave, the sound of their roaring engines gradually replaced by the whisper of a cold wind over the waves. The battle was over.

Officers would fight on

Only three Japanese ships from the original 10 had survived the massacre, but on board the mood was desperate. One desperate officer onboard the destroyer *Yukikaze* even believed the suicide mission should continue. Before sailing, they could fish survivors out of the sea.

"But no wounded. Only men who can fight", he argued.

The officer was overruled by his colleagues and after the mission had been officially cancelled from headquarters, the three ships began to search for survivors.

The captain of sunken cruiser *Yahagi*, Tameichi Hara, had already been in the sea for 20 minutes when he saw *Yamato* sink. He'd attached himself to a large log with a piece of rope, so he'd remain floating even after death. In the distance he could hear patriotic songs being sung by other survivors as they tried to keep death at bay. Hara thought back to his childhood and youth while the waves washed over him. He relieved his mother's songs, his grandfather, days at school and his affair with a beautiful geisha. He began to cry.

Hara continued to sob until he heard the sound of a destroyer: *Hatsushimo*. The search party had found him, and the captain was hauled onboard and served a cup of sake. He sat down with the cup in his hand:

"I've fought my last battle", he said stubbornly.

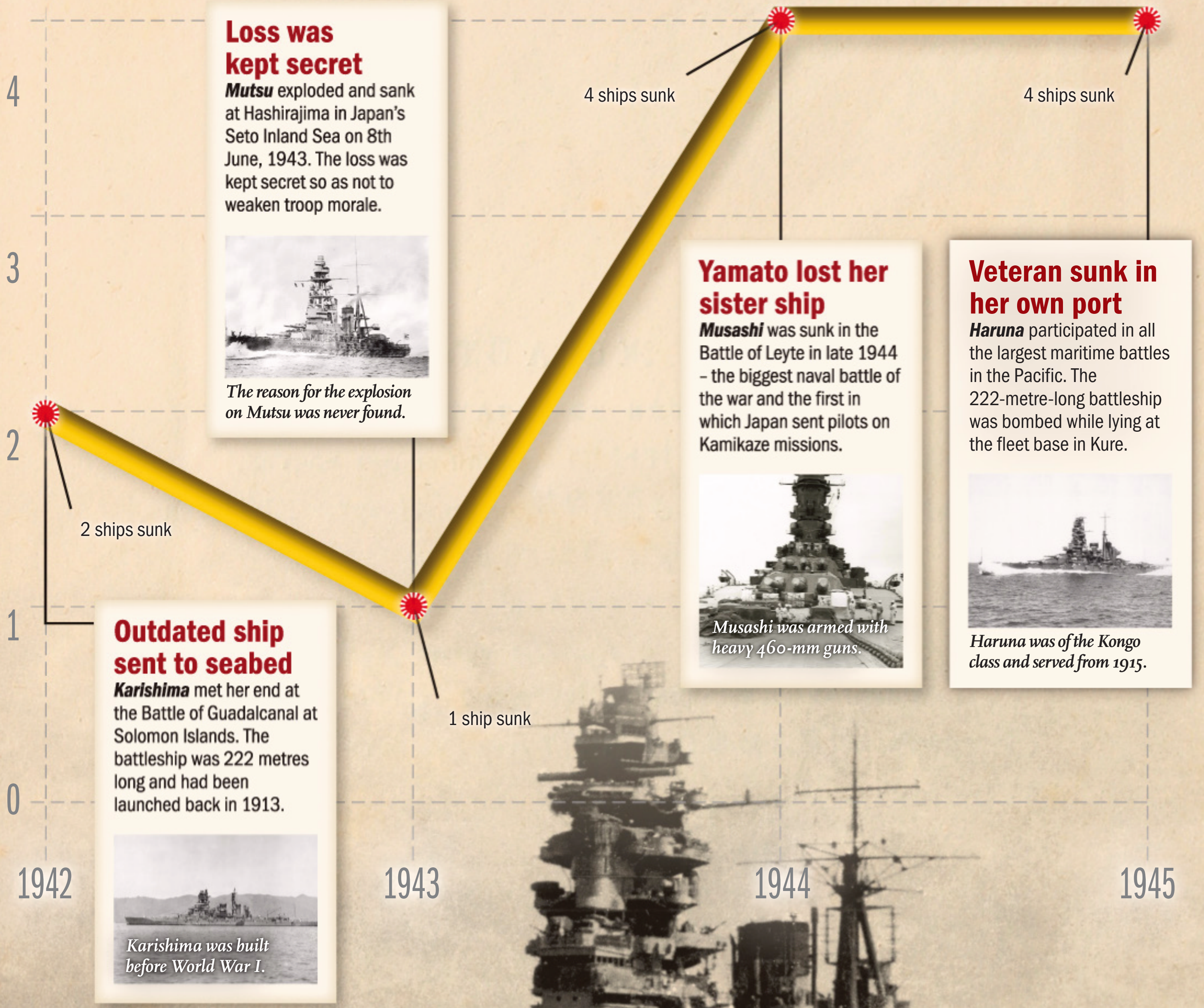
Young gunner Masanobu Kobayashi continued to float around and couldn't believe he was still alive. After the explosion, he was pulled under the water and lost consciousness briefly. But he resurfaced, gathered himself and was now clinging on to the base of a bed with three fellow sailors. The light was vanishing, and the cold was close to killing him. But after four and a half hours in the water, *Yukikaze* found the small group of survivors, and the crew threw a rope down into the water. Kobayashi tied it firmly around his waist and was pulled onboard. The young sailor had survived the shipwreck.

Under cover of darkness, the three surviving ships sailed back to Japan. The operation had lasted no longer than a day, but had cost over 4,000 people their lives, 2,475 from *Yamato* alone. The ship's commander, Vice Admiral Seiichi Ito was among them. According to eyewitnesses, he had bound himself to *Yamato*'s heavy compass to make sure he went down with the ship.

A Japanese three-barrelled emergency flare gun, each containing a different colour to send three distinct signals.

Battleships were wrecked

At the start of the war, the empire possessed over 12 battleships – by August 1945, only one remained. The ships were equipped with massive firepower, but the heavily armoured combatants couldn't cope with swarms of bombers from US aircraft carriers.



Outdated ship sent to seabed

Karishima met her end at the Battle of Guadalcanal at Solomon Islands. The battleship was 222 metres long and had been launched back in 1913.

Karishima was built before World War I.

Loss was kept secret

Mutsu exploded and sank at Hashirajima in Japan's Seto Inland Sea on 8th June, 1943. The loss was kept secret so as not to weaken troop morale.

The reason for the explosion on Mutsu was never found.

Yamato lost her sister ship

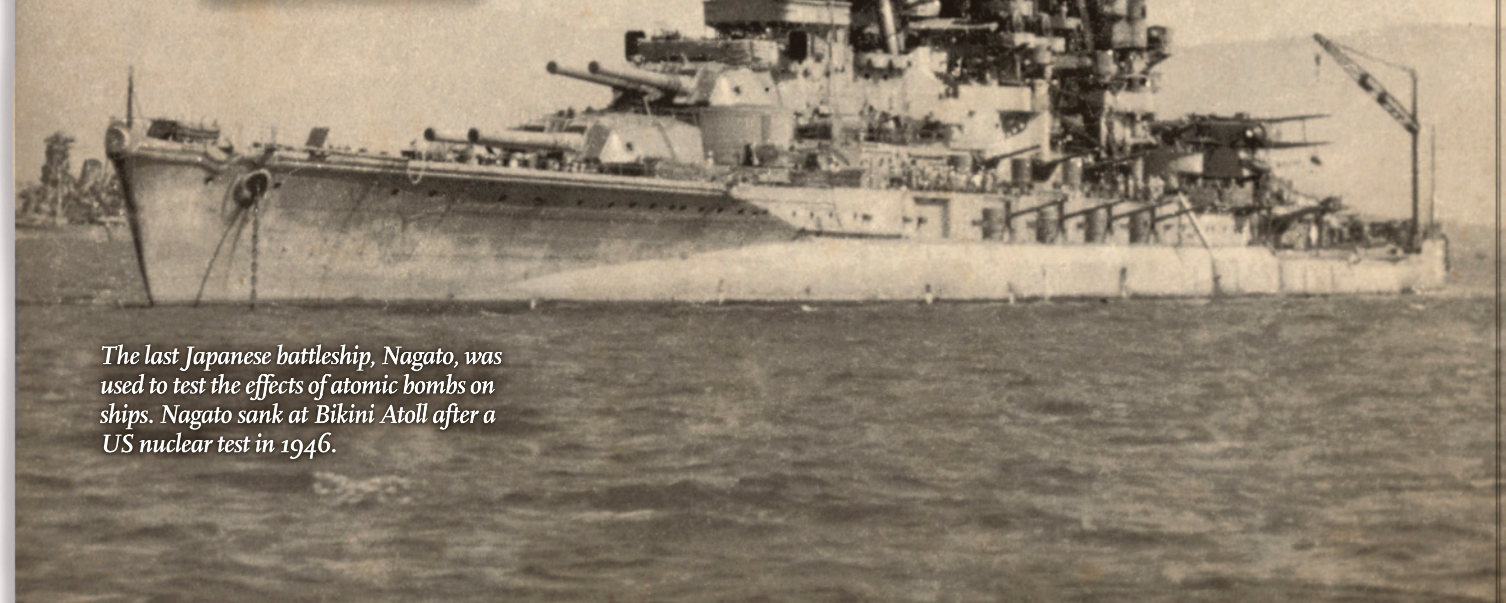
Musashi was sunk in the Battle of Leyte in late 1944 – the biggest naval battle of the war and the first in which Japan sent pilots on Kamikaze missions.

Musashi was armed with heavy 460-mm guns.

Veteran sunk in her own port

Haruna participated in all the largest maritime battles in the Pacific. The 222-metre-long battleship was bombed while lying at the fleet base in Kure.

Haruna was of the Kongo class and served from 1915.



The last Japanese battleship, Nagato, was used to test the effects of atomic bombs on ships. Nagato sank at Bikini Atoll after a US nuclear test in 1946.

The world's only example of the Ho 229 V3 has been in the United States since 1945.

1945

14TH APRIL

INVISIBLE PLANE IS HITLER'S LAST HOPE

In the final months of the war, two German brothers are tasked with building a revolutionary new aircraft that can't be seen by Allied radar. If the plane is finished in time, it might halt the impending German defeat.

Germany, 1945

THE STAGE IS SET

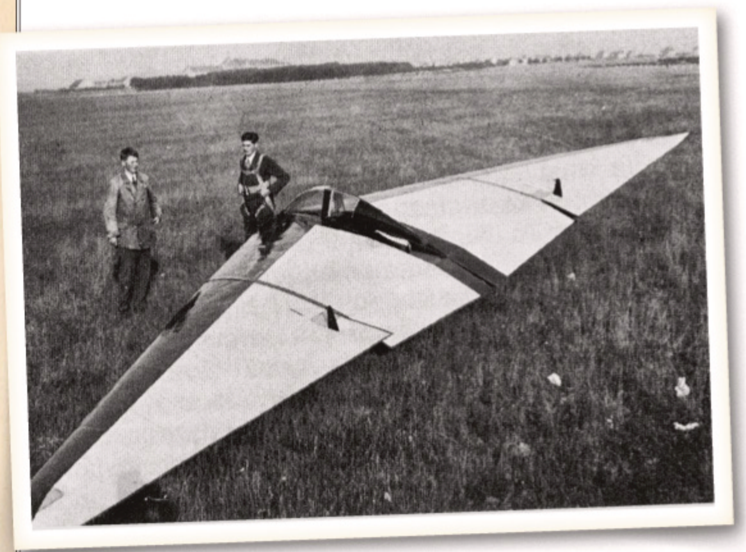
GERMANY
Frankfurt

In 1945, the Wehrmacht has its back against the wall. Allied armies are storming into Germany from both east and west, but Hitler refuses to acknowledge defeat and places his trust in new superweapons to reverse the fortunes of war. One such weapon is a state-of-the-art plane that's decades ahead of its time.

Luftwaffe eagles had the wing tips pointing up to differentiate them from army and navy badges.

Soldiers from the US 3rd Army jumped down from the truck and approached the abandoned hangar. In the distance, shots could be heard from the advancing Allied troops and retreating German armies. The hangar stood in a forest in a remote part of central Germany. Reliable intelligence said it was part of a weapons factory that stored one of Hitler's feared "Wunderwaffen" – ground-breaking new weapons that would turn the war back in the Nazis' favour. But now, in mid-April 1945, Hitler's Third Reich was approaching its fall, and the Americans desperately hoped to root out the advanced weapons before other Allied troops. The inventions contained new technology that must not – for the sake of the western world – fall into the hands of the Red Army, who were swarming through Germany from the east.

The Americans pushed the hangar door open, at which point light fell into the room to reveal a wondrous machine. On the floor lay a disassembled plane with such unusual shapes that at first the soldiers didn't understand what they'd found. Although the wings hadn't been mounted, it was clear the machine was completely different to other hunters and bombers. Its shape was reminiscent of a bat. When the smooth grey-green plane with painted Swastikas was assembled, it was one large wing that ended in a slight tip. The plane had no propellers; instead, two jet engines of a brand new and hyper-advanced type were embedded in the fuselage on either side of the one-man cockpit. There was no doubt in the American's minds: they really were looking at one of Hitler's superweapons. After checking the Allied list of wunderwaffen, it soon became clear that the plane discovered in this deserted hangar in the forest was the legendary "invisible" Ho 229 jet fighter.



Reimar and Walter Horten's first glider was completed in 1933 and was named Ho I.

GERMANS BUILT GLIDER

The men behind the unique machine were German brothers Reimar and Walter Horten. The boys had been obsessed with aircraft from childhood and did all they could to absorb as much knowledge about planes as possible. Their long experience constructing both model aircraft and gliders was pivotal during the development of the Ho 229 stealth fighter.

During their adolescence, the brothers repeatedly entered Germany's national model aircraft championships with their own home-built models. The Treaty of Versailles had blocked the construction of motorised and armoured aircraft in Germany, and so the glider became popular in interwar Germany.

From 1925, the Hortens began building models from wood and plywood. The technically gifted Reimar was particularly absorbed by a single-wing design. This design – better known as a flying wing – has no tail section; instead both wings and body go out as one. The design required intricate mathematical calculations for everything from buoyancy to landing. As the brothers gained more experience, their flying wings became better and more stable and could soon fly further than the competition's conventional designs. The brothers won first place three years running from 1930-32 at the championships, which took place on Wasserkuppe mountain near Frankfurt.

Success gave them hunger for more, and in 1932 17-year-old Reimar and 19-year-old Walter decided it was time to build a full-size flying wing with them as pilots. The plane was named Ho I and was completed in 1933. In the summer of 1934 the brothers proudly headed to the glider championships where they collected 600 Reichsmarks for the most innovative design. But problems getting the plane home forced them to burn all but the most valuable metal parts. Reimar announced he would build a new model as soon as possible – this one with a motor, and received permission from Hitler, despite it contravening the Treaty of Versailles. As with Ho I, Ho II was built at the

Reimar family home in Bonn. People passing the house on the Venusbergweg must have wondered what was going on when – for example – a wing stuck out of one of the windows. For the plane to leave the building, the double doors to the living room had to be removed while the wings scraped across the parquet floor. Despite the wear and tear on their home, Max and Elizabeth Horten fully supported their sons' project.

By the time Ho II had been completed in May 1935, it was too late for the brothers to sign up for that year's championships. At the same time, both men were conscripted to the Nazi regime's mandatory two years of military service. While Walter became a fighter pilot, Reimar performed his military service as a flight instructor at the Luftwaffe's based in Cologne. But what initially looked like a setback for their development work soon became a huge opportunity. The base received a new commander, Major Oskar Dinort, who was passionate about gliders and had set the world record for the longest flight with 14 hours and 43 minutes on the wing. As soon as Dinort saw Reimar's aerodynamic Ho II, he wanted one, and several other officers also placed orders. Soon Reimar was given his own workshop at the airfield, where he also developed new motorised models.

The small planes were built from wood and light metals, using less fuel to allow them to fly longer than conventional types of plane. The brothers' work started to receive serious attention from experts, and in 1938 Reimar and Walter received the Lilienthal Prize for Innovative Design along with 5,000 Reichsmarks. The money made it possible for them to finance one year's aviation studies at the Technical University of Berlin.

BROTHERS CREATED A FAKE SPECIAL UNIT

In 1939, the Nazis invaded Poland. World War II was underway, and both brothers were called up to the Luftwaffe. But Walter was shrewd and quickly found a loophole in the German military machine to allow them to continue uninterrupted development with a fake top-secret project, Sonerkommando L In 3. Walter used all his charm to persuade a secretary – whom he later married – in the German aviation ministry to forge her boss's signature so Reimar could be transferred to the working group.

Sonderkommando L In 3 provided a cover for Reimar's workshop where he could – among other things – experiment with designing aircraft that were invisible

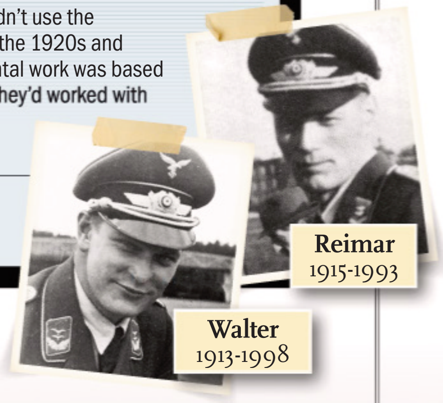
NAME **WALTER & REIMAR HORTEN**

TITLE AIRCRAFT DESIGNERS

Flying wing led brothers to success

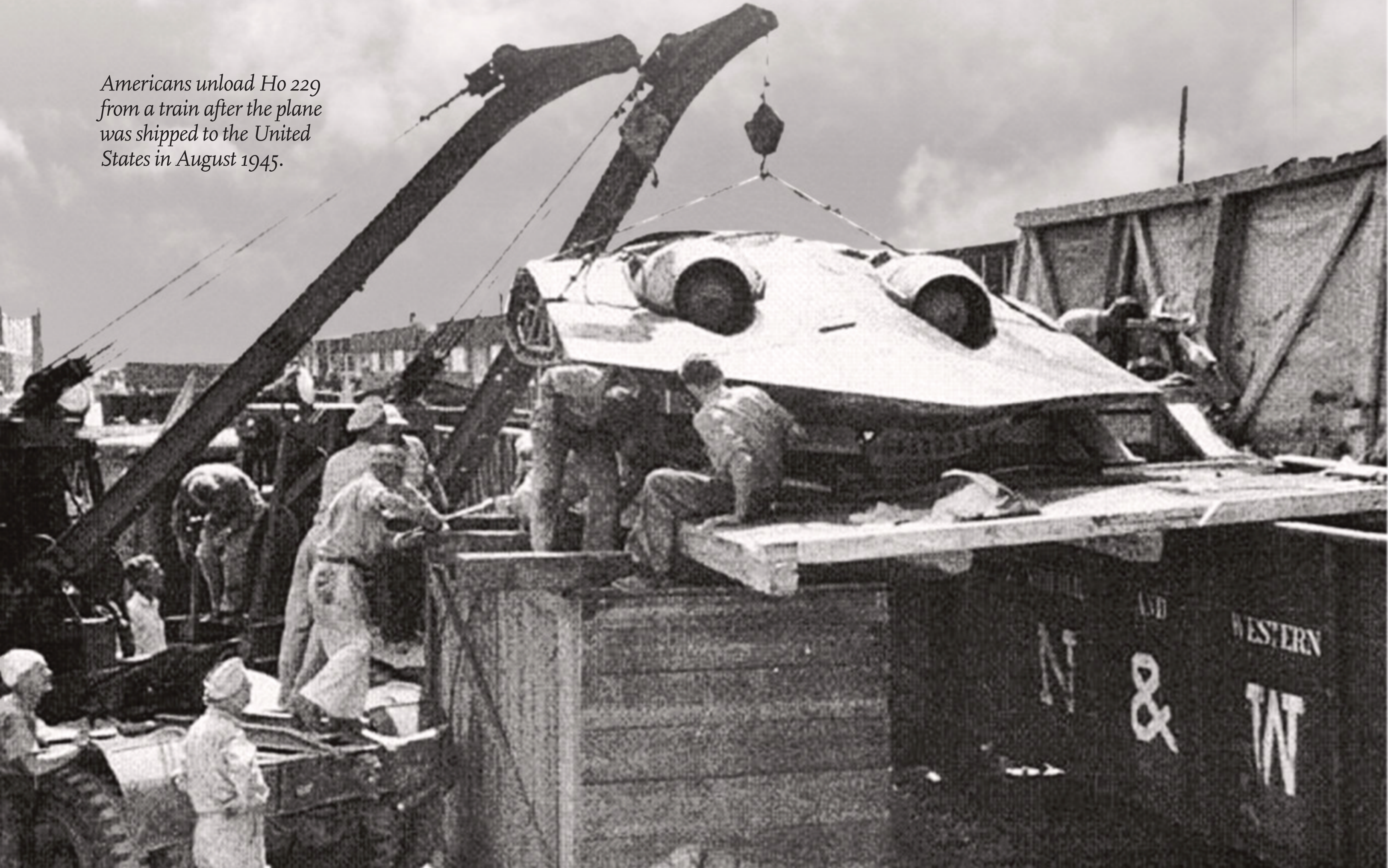
Despite no formal training in aviation engineering, brothers Walter and Reimar Horten managed to develop some of the most advanced planes in the 1940s. One of the reasons for their success was the fact they didn't use the conventional designs favoured in the 1920s and 1930s. Instead, their developmental work was based on a single-wing design – a form they'd worked with since becoming members of a flying club in 1925.

- **Both joined the Hitler Youth.**
- **Members of the Nazi party.**



Reimar
1915-1993

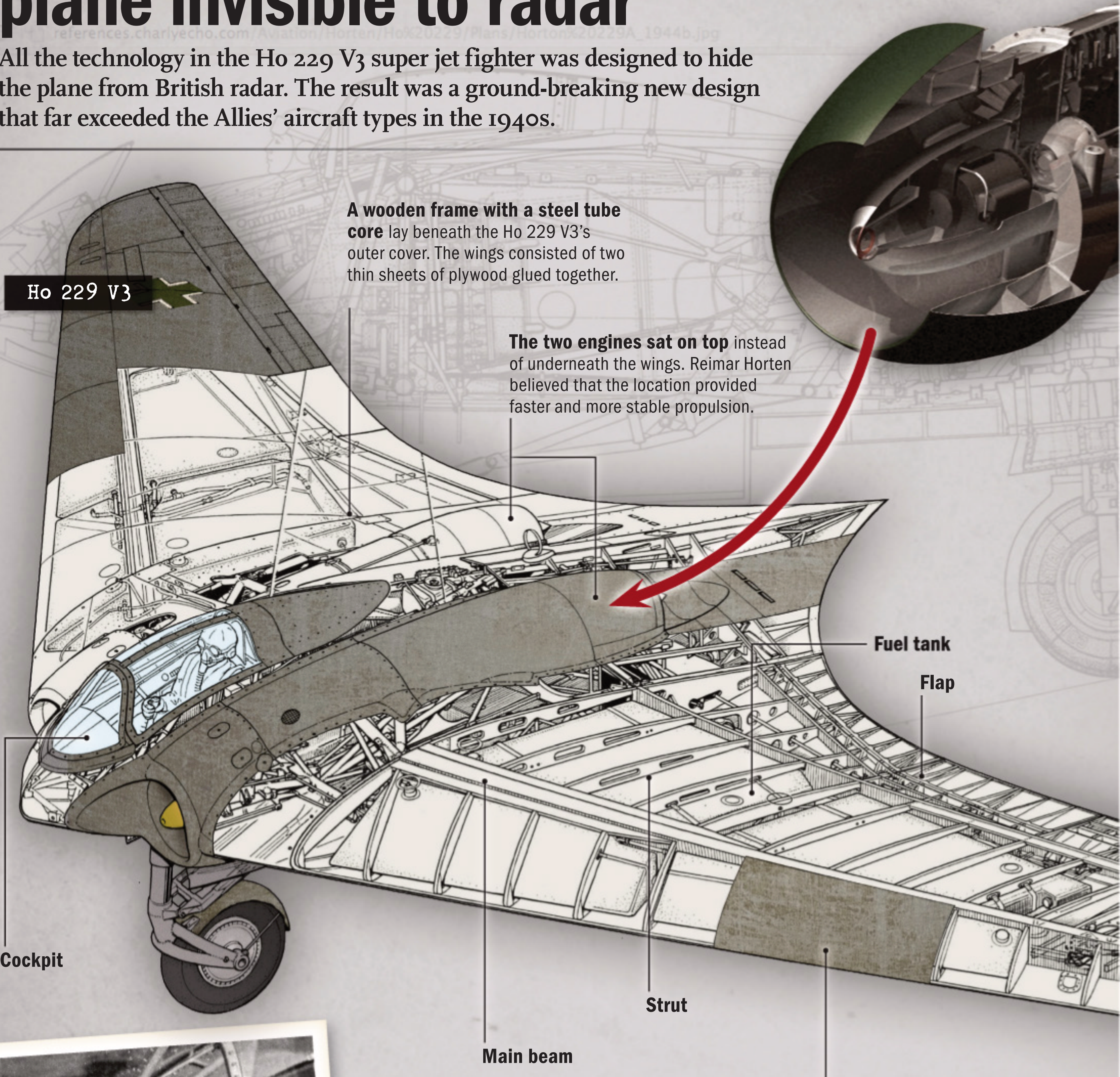
Walter
1913-1998



Americans unload Ho 229 from a train after the plane was shipped to the United States in August 1945.

Wing form and paint made plane invisible to radar

All the technology in the Ho 229 V3 super jet fighter was designed to hide the plane from British radar. The result was a ground-breaking new design that far exceeded the Allies' aircraft types in the 1940s.

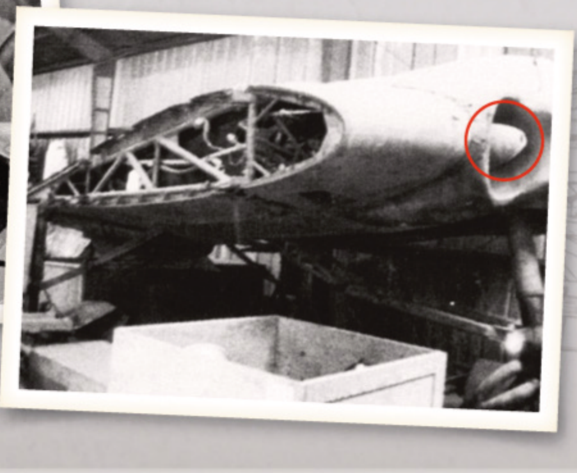


A wooden frame with a steel tube core lay beneath the Ho 229 V3's outer cover. The wings consisted of two thin sheets of plywood glued together.

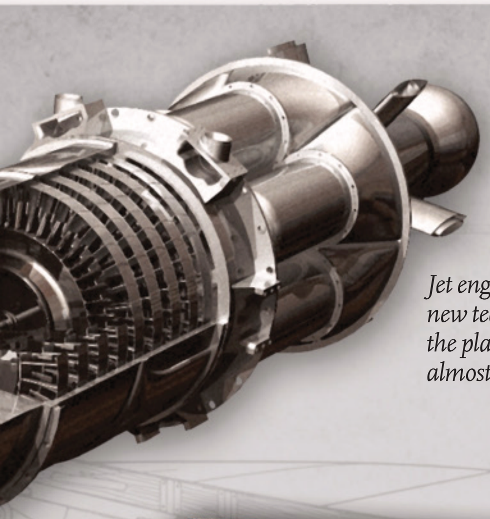
The two engines sat on top instead of underneath the wings. Reimar Horten believed that the location provided faster and more stable propulsion.

Coal dust and sawdust mixture was painted on the surface of the aircraft to absorb radar waves so that the plane's inner metal parts didn't reflect the waves back to the station.

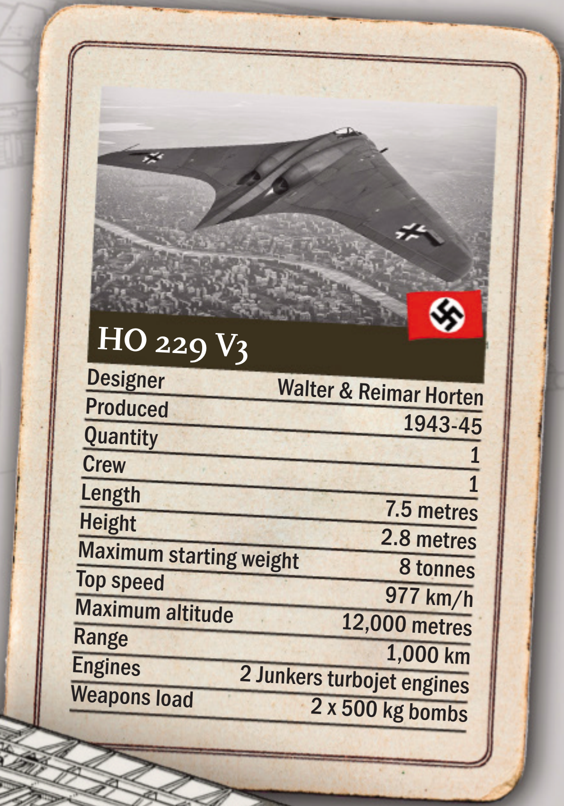
The pilot wore a pressure helmet due to the high altitude.



The jet engines were located between the cockpit and the detachable wing.

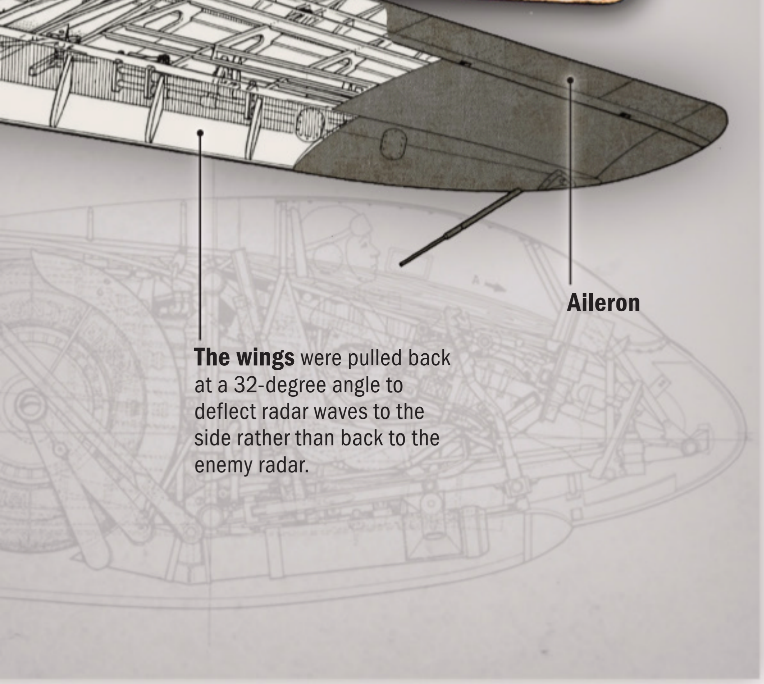


Jet engines were a whole new technology and gave the plane a top speed of almost 1,000 km/h.



HO 229 V3

Designer	Walter & Reimar Horten
Produced	1943-45
Quantity	1
Crew	1
Length	7.5 metres
Height	2.8 metres
Maximum starting weight	8 tonnes
Top speed	977 km/h
Maximum altitude	12,000 metres
Range	1,000 km
Engines	2 Junkers turbojet engines
Weapons load	2 x 500 kg bombs



The wings were pulled back at a 32-degree angle to deflect radar waves to the side rather than back to the enemy radar.

Luftwaffe mechanics wore a black oblique cap, which was also used by air defence personnel.

to enemy radar. The younger Horten combined a flying-wing design with a radar-absorbing coat of glue mixed with coal dust to create the world's first stealth plane.

The brothers continued the scam and ordered materials to their home using several forged signatures. "If the Air Ministry had found out about our prior activities, we could have been in very difficult times", Reimar later confessed, but despite the threat of a harsh prison sentence, Walter deemed that Reimar's work carried greater weight.

The enemy's new radar technology had proved its worth during the Battle of Britain from July to October 1940. Walter had watched as one good pilot colleague after another had been shot down thanks to the RAF's efficient Chain Home early-warning system. In addition, the German fighter Messerschmitt Bf 109 had proved less agile than the British Spitfire. Reimar had to construct a superior German fighter plane, one both twice as fast as a Spitfire and difficult for the British radar system to detect.

Brothers impressed Göring

Thanks to a stroke of luck, Walter had been transferred from active fighter pilot to technical advisor in the newly created Jagdfluginspektion (Fighter Inspection Command). Here he became acquainted with a new advanced technology: jet engines. The engines, which had been developed by BMW and Junkers, would be part of a new generation of German fighters. Walter realised that propellers would soon be obsolete when he saw the sketches of the Messerschmitt Me 262 turbo jet fighter and later attended the first test flight of the tailless rocket-powered Lippisch DFS 194 aircraft.

Walter used fake signatures to order jet engines and gather a 170-man working group for the fictional Sonderkommando L In 3. In order to make the project look official, his brother always appeared in official Luftwaffe uniform.

In mid-1943, as Reimar was working on the brothers' most advanced project yet, a single-wing turbo jet, Hermann Göring issued a call to the Nazi airline industry. The Luftwaffe boss demanded that a fighter plane be developed that could be loaded with 1,000-kg bombs and fly 1,000 kilometres with a top speed of 1,000 km/h. The Horten brothers didn't hesitate and immediately submitted their new project entitled Ho 229.

After a few weeks, the call came to meet at Göring's country house Carinhall, north-east of Berlin. As Reimar presented his sketches, Göring's eye widened – particularly when he realised that Reimer's flying wing was the only one of those proposals submitted that came close to fulfilling his brief.

At the end of the meeting, Göring got up excitedly: "Do it. Make it and let me see it".

With Göring's support, Ho 229 went from a dubious backyard project to a high-profile superweapon designed to save the Third Reich. Ho 229 was to be built at the Gothaer Waggonfabrik aircraft factory, but with Germany pushed back on both fronts and a substantial lack of materials, the project was little more than a pipe dream. Nevertheless, Reimar worked day and night, even as the Americans crossed the Rhine in the spring of 1945 and British planes bombed German cities.

His calculations and test flights allowed Reimar to discover that the jet engines should sit on the top of the wing for maximum effect. He also had to adapt the cranks, brakes and flaps to the powerful engines, otherwise the flying wing risked the dreaded "Dutch roll", a movement whereby the plane would rock uncontrollably from side to side. Although the super plane was expected to roll out in six months, due to problems with the engines that were 12 centimetres too long, the project fell behind schedule. It wasn't until 18th December, 1944 that Ho 229 – the world's first jet-powered single-wing fighter – went into the air. A proud Reimar Horten watched his unique plane from the ground.

The Ho 229's success reached high up in Nazi circles and triggered a new meeting with Göring. They met several times and the Luftwaffe chief became increasingly spellbound by the brothers' work as their relationship became increasingly familiar. "It was like a speech from a father to a son", Reimar recounted about Göring's comments later.

During one of the meetings, Göring asked what Reimar wanted to do after the war: "I told him I will go to Freiburg and... I will develop planes there", the younger Horten recalled later. "Göring answered: 'I will need one hangar for Lufthansa'. He meant that he agreed that he would give me all the hangars there except one to make sailplanes and carry out design work".

Test pilot was flung from plane

The Horten brothers' lifelong project was close to success when disaster struck. In February 1945, during the test flight of the second version of the flying-wing plane, one engine cut out. The pilot extended the landing gear too soon, disrupting the plane's balance. To the horror of those watching, the unique plane went into a series of spins before smashing into the ground while the pilot was thrown from the cockpit into some fruit trees. When help arrived, he was found dead among the trees' branches.

The crash forced the Horten brothers to build a new prototype from scratch. But although Reimar and Walter burned for the cause, they recognised in March 1945 that Germany was close to defeat. Their new, improved prototype – Ho 229 V3 – would never be completed, even though the factory was working at full stretch.

On 14th April, 1945, it was finally all over. US soldiers stormed the secret hangar and shortly after Reimar and Walter Horten were sent – with other German engineers and scientists – to Britain for interrogation. But initial excitement faded quickly. The experts leading the brothers' interrogation simply didn't understand the flying-wing design. The incomplete aircraft was, however, shipped to the US where it would be assembled and examined.

After their release, Reimar and Walter briefly worked for the British. The idea was to build flying wing planes that could be used for passenger flights on intercontinental routes, but the project was quickly shelved in 1946. Walter then returned to Germany until his death in 1998, while Reimar emigrated to Argentina in 1949 where the country's dictator Juan Perón offered well-paid work to German engineers and weapons experts.

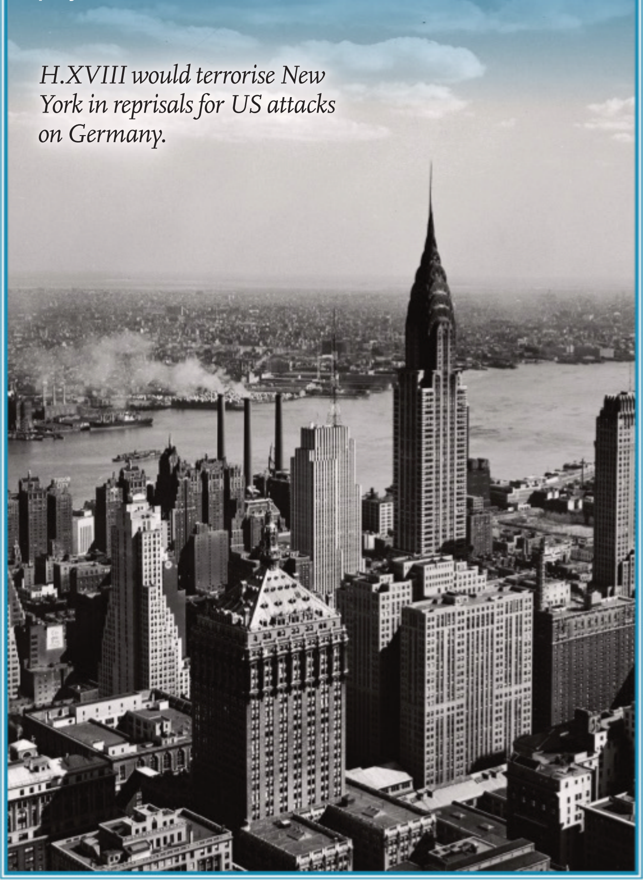
The Hortens' flying wings were decades ahead of their time. The US only really realised the potential of stealth technology with the B-2 Spirit bomber in 1988, which boasted many similarities to the Ho 229 V3. After a lifetime in obscurity, Reimar Horten finally gained full recognition for his work in 1993 when the Royal Aeronautical Society awarded him a Gold Medal for his outstanding efforts.

"Amerika bombs" would strike United States

Build a plane to reach New York, drop four tonnes of bombs and return to Germany. These were the demands of the German Amerika Bomber project.

From 1942, the Germans tried to develop a plane or rocket that had a range of 11,000 kilometres. The aircraft would be able to reach the United States with a bomb load of four tonnes and then return safely to Germany.

Reich Minister of Aviation Hermann Göring also invited the Horten brothers to contribute to the work, called the Amerika Bomber project. The visionary brothers drew up the single-wing H.XVIII bomber. The plane was based on the Ho 229 jet fighter, but was much larger with a wing span of 40 metres and powered by six jet engines. H.XVIII also possessed stealth features and would only been seen on radar screens when 20 kilometres from the US coast. The bomber, like all other Amerika Bomber projects, was never realised, however.



H.XVIII would terrorise New York in reprisals for US attacks on Germany.

Ho 229 laid the foundations for today's stealth planes

Modern stealth aircraft use a special coating and shape that prevents radar waves from detecting the planes, just like the Horten brothers' superweapon. Today, the technology is employed by Russia, China and the United States.

The Chinese demonstrated a prototype of Shenyang J-31 at an aerospace exhibition in China in 2014.

Doubts of Chinese invisibility

China is currently developing the stealth fighter Shenyang J-31. The plane is believed to be able to brush off several types of radar wave, but aviation experts outside China are uncertain about what gives the fighter its stealth properties. Like the Ho 229, it may simply be a surface coating. The plane's top speed is 2,200 km/h. Its total weight is 17,600 kilograms.

The Sukhoi Su-57 flies under the radar at over 2,000 km/h.

Russians test stealth fighter

Russia is in the final stages of testing the country's first stealth aircraft – the Sukhoi Su-57 (prototype name T-50). Its stealth features are based on the plane's shape and angles. In addition, the antennae are recessed and its weapons – machine guns and missiles – are placed inside the aircraft so radar can't detect them. Finally, Sukhoi has been treated with radar-absorbent material (RAM), which reduces the reflective ability of radar waves.

The fighter plane has a top speed of 2,440 km/h, a range of 3,500 kilometres (without refuelling in the air) and a maximum altitude of 20 kilometres. Armaments consist of a total of 30 missiles.

Stealth plane shot down

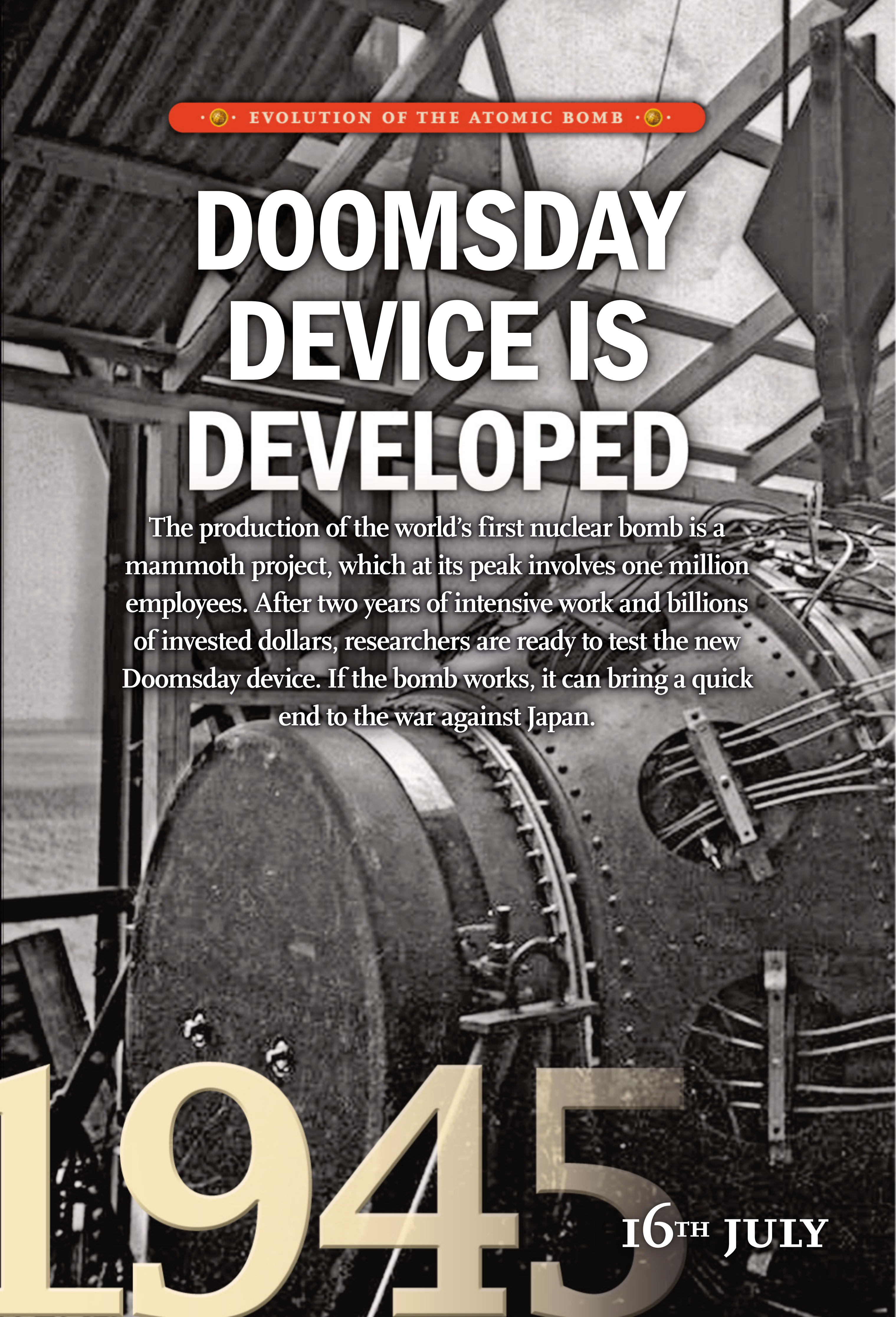
A total of 64 US F-117 Nighthawk aircraft were used during several wars, including in Iraq in 1991 and 2003, Afghanistan in 2001 and Yugoslavia in 1999. The Yugoslavs got lucky and shot down a Nighthawk with ground-to-air missiles because their radar detected the plane's open bomb hatches. The pilot ejected and was rescued around eight hours later.

In 2008, the Nighthawk was retired after 25 years of service in the US Air Force.

Despite its stealth properties, a Nighthawk was shot down by a missile over Yugoslavia in 1999.

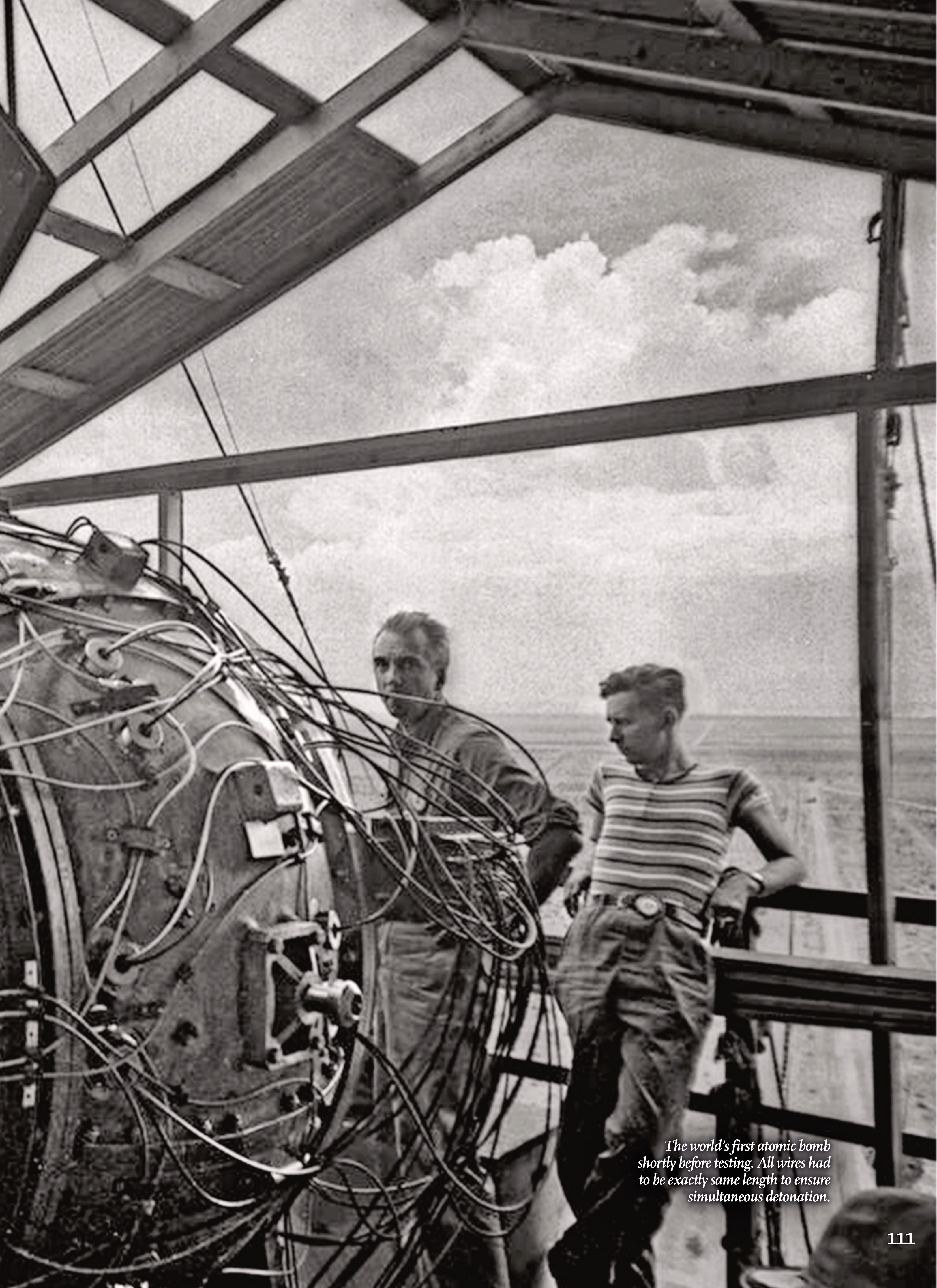
DOOMSDAY DEVICE IS DEVELOPED

The production of the world's first nuclear bomb is a mammoth project, which at its peak involves one million employees. After two years of intensive work and billions of invested dollars, researchers are ready to test the new Doomsday device. If the bomb works, it can bring a quick end to the war against Japan.



1945

16TH JULY



The world's first atomic bomb shortly before testing. All wires had to be exactly same length to ensure simultaneous detonation.

New Mexico, 1945

THE STAGE IS SET

USA
New Mexico

Researchers in Nazi Germany are working hard to develop a nuclear bomb. The Allies know that if Hitler gets the bomb first, its unimaginable destructive power could determine the war. The US therefore strives to win the race. But nobody knows what will happen when the first bomb is ready for trial in the desert.

THE COUNTDOWN HAD BEGUN. In 20 minutes, the team behind the development of the new Doomsday device would learn whether their efforts had been fruitful. Everyone was filled with a sense of foreboding.

In the days leading up to the explosion of the world's first atomic bomb, researchers made several predictions. Many assumed that the bomb would not work at all, while others bet money on the bomb wiping out all of New Mexico. Those with a gallows humour had bet it would ignite the Earth's atmosphere and put an end to mankind.

Soldiers associated with the Manhattan Project bore a special shoulder patch.

Scattered troops of soldiers, officers and scientists craned their necks, 15 kilometres away from the bomb. Most had been waiting all night, stomping around in the desert sand to keep warm. At short intervals they turned to the south-east – towards "The Gadget". Everyone was equipped with welding goggles, in case they weren't able to turn their face away from the explosion in time.

"Dark glass, everyone", commanded an officer.

"To hell with that", a physicist retorted. "I'm going to see this. Even if it's the last thing I see".

Finally! Red signal flares lit up over the desert. In seconds, everyone would know if their work had been in vain.

THE WORLD ENTERED A NEW AGE

The experiment was the culmination of decades of research. Around 1900, physicists Pierre and Marie Curie concluded that an atom's nucleus could potentially release huge amounts of energy. They knew that the nucleus consisted of tight neutrons and protons that were bound together by a mutual binding energy. At that point, the nuclei had been considered stable and indivisible. But the Curies believed that the particles could be separated and that the energy generated would be millions of times greater than if the same substance was burned in a conventional manner. The only thing the couple didn't know was how to harness this energy source in practice.

The project's sharpest minds were gathered in a secret location in New Mexico.

Until 1930, only small progress was made. Even Albert Einstein rejected the idea that discharge from nuclear energy could happen faster than natural radiation. It wasn't until 1932 that Briton John Cockcroft and Irishman Ernest Walton succeeded in splitting an atom. Even then, the split did not trigger enough energy to start a chain reaction.

The breakthrough came in December 1938. German scientists Otto Hahn and Fritz Strassmann discovered that they could split the atoms of the element uranium. The two chemists sent a manuscript to the German scientific journal *Naturwissenschaften* and reported that they had found traces of the element barium after bombarding uranium with neutrons. Two other researchers, Lise Meitner and Otto Robert Frisch, correctly concluded that the result was due to a process called "bond cleavage", the splitting of the uranium atom's chemical bonds. Shortly afterwards, French physicists discovered that the atomic cleavage released neutrons from uranium atomic nuclei. The speculation now began to determine whether these "free-flowing" neutrons could split the surrounding uranium atoms to start a chain reaction.

SCIENTISTS HAD TO SOLVE THREE PROBLEMS

On 1st September 1939, Hitler invaded Poland, and World War II became a reality. By coincidence on the same day the Danish physicist Niels Bohr had published a small article in the scientific journal *The Physical Review*. Bohr wrote that with the right amount of uranium-235, a rare variant of the element, it was possible to trigger an unimaginable amount of energy.

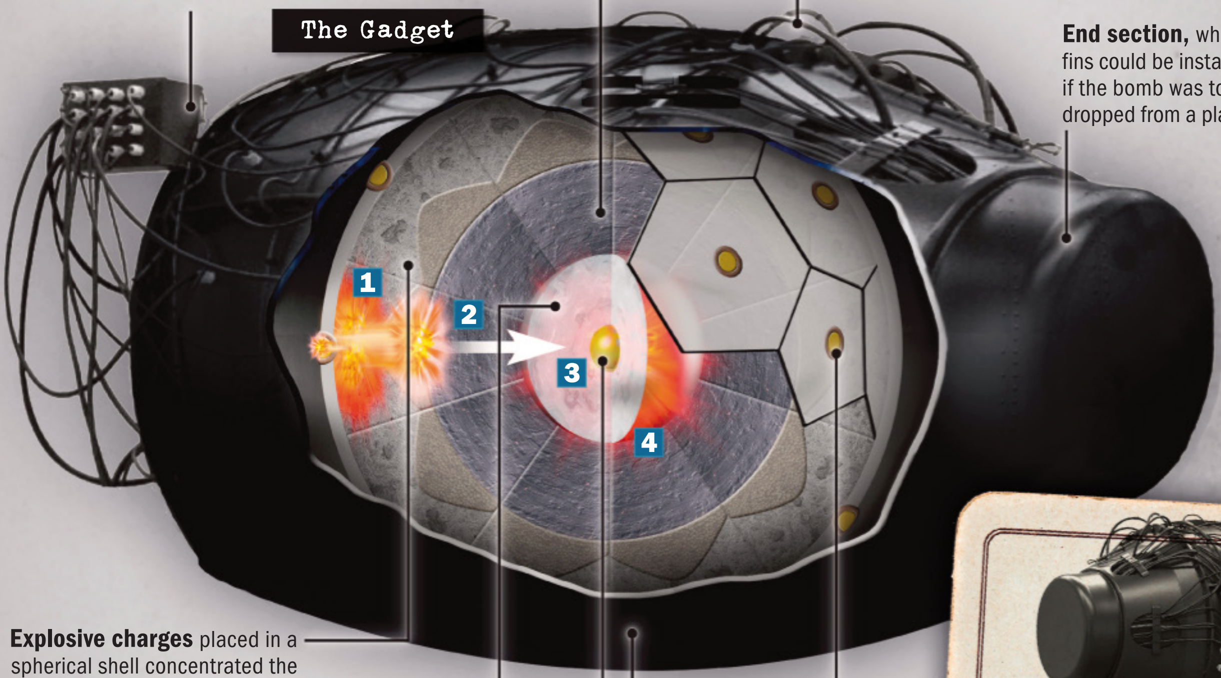
Even before the war broke out, several German researchers had drawn similar conclusions. Many had fled from Germany during the 1930s, and after the outbreak of war, several of these scientists warned the British government that Germany would certainly try to construct a Doomsday bomb. The warning was passed on to Britain's allies, and soon several countries were researching bomb development.

The researchers' challenge was threefold: first, find out how much uranium-235 equated to Bohr's "right amount"; second, to actually acquire uranium-235, and finally to construct the mechanics of the bomb. The most expensive challenge was to procure uranium-235. Over

Explosives triggered chain reaction

The world's first atomic bomb, The Gadget, was built like an onion. An outer shell of explosives compressed inner shells together to set off a nuclear reaction.

When the bomb was armed, a green plug was replaced with a red.



Capacitor box sent precisely timed pulses to 32 detonators via wires.

Thick aluminium shell amplified the implosion wave.

Detonator wires were exactly equal length to ensure simultaneous explosions.

End section, where fins could be installed if the bomb was to be dropped from a plane.

Explosive charges placed in a spherical shell concentrated the burst in the centre.

The uranium-238 neutron reflector increased the implosion and thus the explosive force.

Steel and aluminium case was lined with cork.

Detonators were triggered electrically, causing the thick explosive blocks to go off.

Plutonium core had a diameter of 9.2 cm, and contained a small neutron initiator that triggered the chain reaction.

1 **Conventional explosive charges,** distributed on the surface of the bomb, are detonated.

2 Explosive charges **press a thick shell of aluminium together** on a ball of plutonium.

3 In the centre of the plutonium ball there is a special substance (called a neutron initiator) whose chemical composition is still a military secret. **The pressure from the surrounding plutonium** compresses the neutron initiator, which emits neutrons.

4 The neutron splits the plutonium and **the chain reaction begins.** The bomb explodes.

The Gadget

Explosive force	18,000 tonnes TNT
Length	2.90 metres
Weight (without casing)	2,800 kg

PRESSURE-GENERATED EXPLOSION

The Gadget was an implosion-type bomb, which meant an inward pressure wave triggered a nuclear explosion. The Gadget was the same type as Fat Man, which was dropped on Nagasaki.

Little Boy, which was dropped on Hiroshima, was based on uranium-235, but the isotope was both difficult and expensive to procure.

> “I'm going to see this. Even if it's the last thing I see!”
>
> Physicist who refused to wear safety glasses during the test

NAME **LESLIE R GROVES**

TITLE BRIGADIER GENERAL

1896-1970

Military man was superb organiser

In September 1942 Leslie Groves took over as head of the top-secret Manhattan Project. Groves didn't have much knowledge of physics, but was an expert in budgets and deadlines, and deftly managed the project and its thousands of employees.

In his book *Now It Can Be Told*, Groves asked the question: was it necessary that the US develop the nuclear bomb? His answer was a resounding yes.

- **Oversaw Pentagon's construction.**
- **Headed one million employees.**

99 percent of all uranium on the globe is uranium-238, while only 0.71 percent is uranium-235.

The Germans started well and had quickly built an efficient reactor. The leading German researcher, Werner Heisenberg, gambled everything on one specific process, which required heavy water. The production of heavy water requires enormous energy, and the Germans hoped to exploit the cheap hydropower in occupied Norway. Allied sabotage of the Norwegian heavy water factory in Rjukan ensured that the Germans never had sufficient supplies.

In addition, the Germans mistakenly concluded that the bomb required hundreds of kilograms of uranium-235, and they considered the costs insurmountable. The Nazi nuclear program crumbled slowly, but the Allies didn't know this and still feared the Nazis would make the bomb first.

BOMB DEVELOPMENT SURPASSED THE AUTOMOTIVE INDUSTRY

The Americans assumed that the German researchers were two years ahead of them. In order to overtake them, therefore, Roosevelt decided to launch the largest scientific project ever in 1941. In secret, the president invested 2.5 billion dollars into the Manhattan Project. The project name derived from its coordination from a discreet office in Manhattan, New York. The office hired every physicist, chemist, engineer and student that could walk or crawl. Even ordinary soldiers with just a superficial knowledge of physics received a train ticket and an order stamped "secret" in their hands. All employees were told to sign up for one of the many colossal factories that sprang up in sparsely populated areas. From the start, over 125,000 people were employed on the Manhattan project.

Despite the size of the project, it was possible to keep the work secret – partly because only a handful of people knew the full extent of the project, but also because the atomic bomb's development occurred in so many different places across the US that it was difficult for outsiders to get an overview.

When the secret factories signed contracts with thousands of workers, they made sure to keep the overall purpose secret, but perks like being able to eat steak every night – coupled with the war and a growing sense of patriotism – ensured people didn't ask too many critical questions when the military called.

When the project was running in top gear, it was bigger than the entire US automotive industry and consumed 10 percent of the US's total electricity production.

NATIONAL BANK LENT 6,000 TONNES OF SILVER

The project's first interim target was reached in a basement under the University of Chicago. In the university's squash court in December 1942, Italian physicist Enrico Fermi succeeded in building a small nuclear reactor, starting a chain reaction and stopping it again. However, conditions did not allow for calculations on chain reactions that would be large enough for the desired bomb.

The next step was therefore to construct far larger reactors. It proved difficult to get enough copper for the electrical systems, however, so in agreement with the US National Bank, which printed notes and denominated coins, researchers were allowed to borrow 6,000 tonnes of silver. Silver is a good conductor of power and could easily be used instead of copper in magnetic coils and electrical conductors.

The huge factories didn't work alone. The Manhattan Project's greatest physicists and engineers were accommodated in caravans outside the small town of Los Alamos situated in a remote, inaccessible area in the state of New Mexico. The site was proposed by the project's scientific leader, J Robert Oppenheimer, who had roots in the area. Its director, Brigadier General Leslie R Groves, viewed the site and approved it because

Pierre Curie
Marie Curie

The couple Pierre and Marie Curie in the laboratory where they discovered the atom's enormous energy potential.

FROM THEORY TO PRACTICE

1898

Wilhelm Röntgen and Henri Becquerel's **discoveries of radiation** result in Marie Curie's hypothesis that radiation is not due to interaction between molecules, but must come from the atom itself. The theory leads to the rejection of the old assumption that the atom was indivisible.

1932

Physicists John Cockcroft and Ernest Walton manage to **split the atom** using instruments that they've designed.

The Gadget test bomb generated a mushroom cloud that reached a height of over 12 kilometres.

"It worked!"

Robert Oppenheimer after the explosion

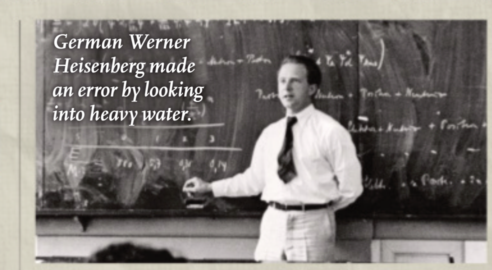
ATOMIC BOMB DEVELOPMENT

1933

SEPTEMBER
Hungarian-born physicist Leó Szilárd hypothesises that an **atomic chain reaction** can take place. Together with his Italian colleague Enrico Fermi, he patents the principle of a nuclear reactor.

1938

DECEMBER
German chemists Otto Hahn and Fritz Strassmann bombard uranium with neutrons and find isotopes of the barium element – **evidence of atomic decomposition**. In 1944 Hahn receives the Nobel Prize in Chemistry for this.



German Werner Heisenberg made an error by looking into heavy water.

1939

APRIL
Nazi Germany launches an atomic programme in collaboration with the physicist Werner Heisenberg. It builds a reactor and the ambition is to **manufacture a German atom bomb**. But the development requires heavy water, which can only be obtained in Norway.

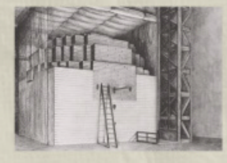
1941

OCTOBER
President Roosevelt gives the green light to the development of **an US atomic bomb.**

1942

JUNE
Physicist J Robert Oppenheimer is appointed scientific leader of the **US atom bomb project**.

2ND DECEMBER
Italian-born physicist Enrico Fermi starts and stops a **controlled chain reaction** in the Chicago Pile-1 reactor as part of the Manhattan Project.



The first controlled chain reaction took place at the University of Chicago.

it was so isolated. Just a single winding gravel road led into the heart of the Manhattan Project. Cut off from the outside world, the sharp minds were left to calculate how much uranium-235 they needed and how the bomb would be constructed.

In 1943, 250 scientists worked in Los Alamos. Two years later, the number had swelled to 3,500 – many with wives and children. There was a lively community in which makeshift buildings were built at great speed, helter-skelter in the dusty landscape under the permanently blue sky. Clothes and freshly washed nappies hung like garlands between the residential barracks. While the women tried to make a life for their families, the men in the laboratories toiled with flasks, Geiger counters and formulas around the clock. But after all the work, they still had time for something else. Several times a week, residents attended large cocktail parties to welcome the latest arrivals. Women gave birth to so many children that the maternity ward at the spartan hospital was overloaded. Theatre and movie nights provided entertainment between the parties.

Despite the carefree life, the community remained top secret, and the many families were effectively cut off. Visits outside were largely prohibited, and residents also discovered all incoming and outgoing mail was censored.

PHYSICS FOCUSSED ON TWO BOMB TYPES

Researchers worked from the start on two different bombs, based on uranium and plutonium respectively – both highly radioactive substances. Plutonium was first produced at the University of California in 1940. The substance was faster and cheaper to produce than uranium-235, but unstable. The mechanics of the plutonium bomb were therefore far more complicated.

Despite friction between the scientists and the military, scientific setbacks and major problems obtaining the required materials for the factories, the US took just 27 months to complete what other nations had been forced to abandon. In the summer of 1945, the giant factories produced around 50 kilograms of uranium-235 plus enough plutonium to produce two atomic bombs. Because of their appearance, the bombs acquired the nicknames "Little Boy" and "Fat Man".

The work wasn't harmless. Physicist Harry Daghlian died from radiation burns after an unsuccessful experiment.

Although it had only been possible to produce a small amount of plutonium, researchers decided to use a part of it for their test bomb. They were unsure whether the plutonium bomb would work. The test bomb was named "The Gadget" and was structurally identical to the Fat Man. Scientists had no doubt that Little Boy, with its deadly load of uranium-235, would explode: the technology behind the uranium bomb was relatively simple.

ENERGY TURNED SAND INTO GLASS

It took three days to assemble and prepare the test bomb. The Gadget was placed atop a steel tower 30 metres high to mimic the impact of a bomb dropped from a plane.

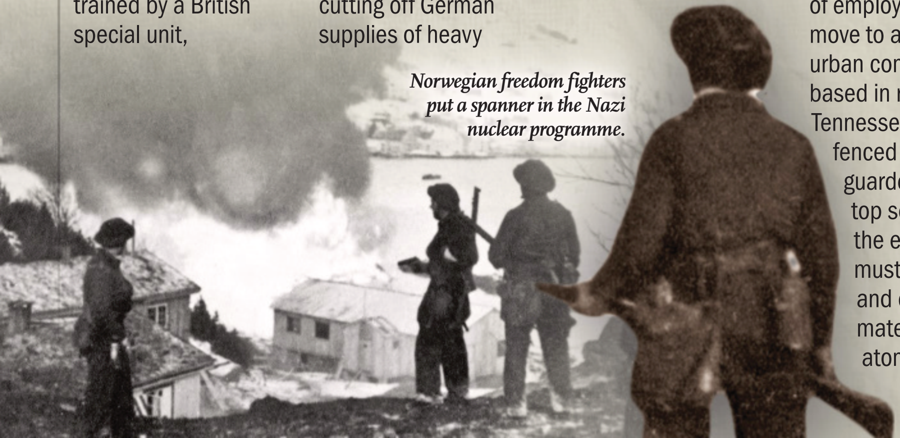
The plan was to blow the bomb at 04.00, but rain and thunder delayed the countdown, which didn't start until

> **"Now we are all sons of bitches"**
>
> Test director Kenneth Bainbridge after the euphoria of the successful test explosion had passed

1943

FEBRUARY

Norwegian soldiers, trained by a British special unit, **sabotage an important heavy water factory** in Norway, thereby cutting off German supplies of heavy water. This makes it harder for the Nazis to develop a German nuclear bomb.



Norwegian freedom fighters put a spanner in the Nazi nuclear programme.

MARCH

The Manhattan Project is expanded by many thousands of employees, who move to a brand new urban community based in rural Tennessee. The fenced and guarded city is top secret, and the employees must develop and deliver materials for the atomic bomb.

1945

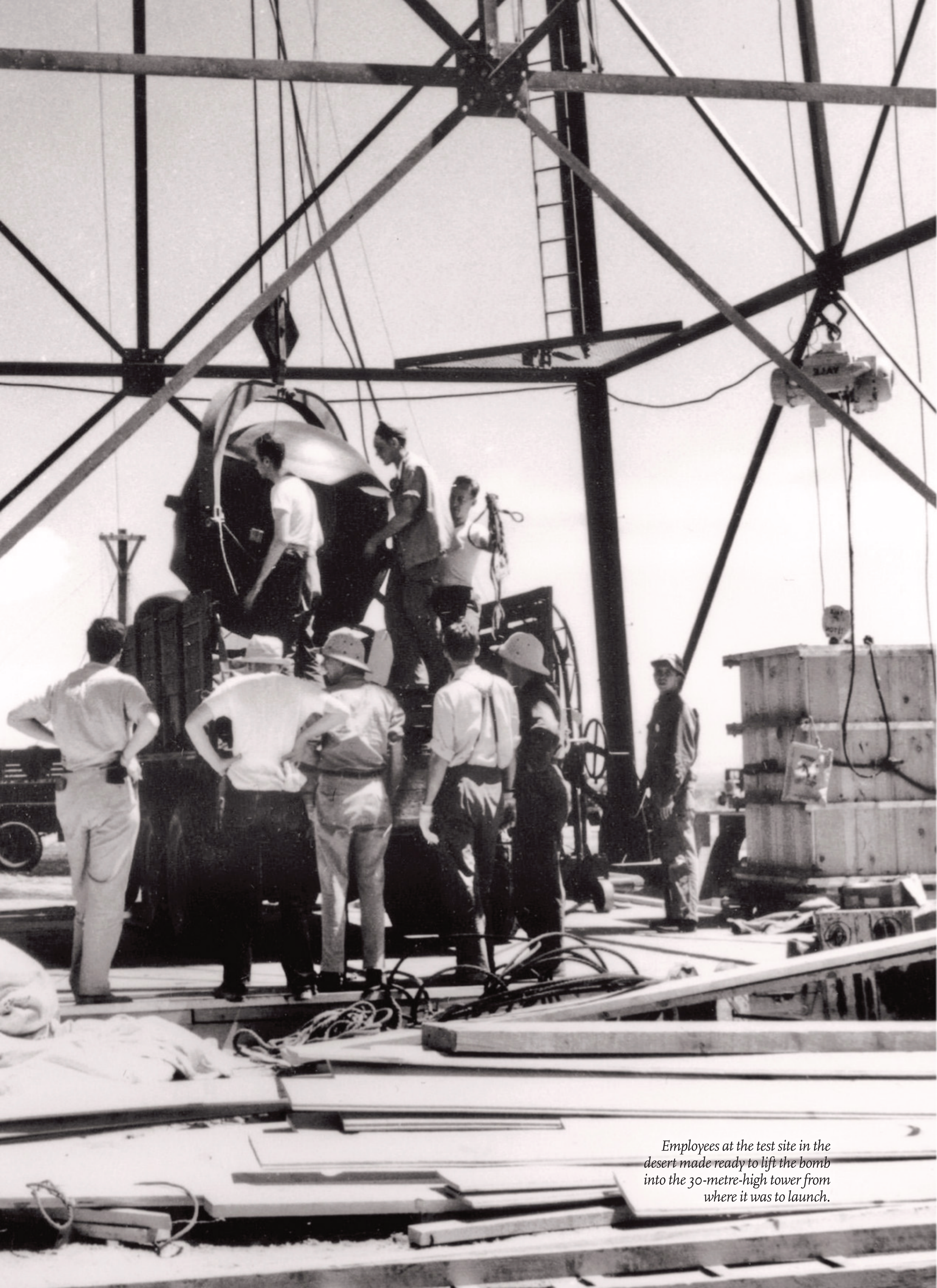
16TH JULY

Under the code name Trinity, the **first atomic bomb is detonated** in a test area in New Mexico owned by the US Air Force.

6TH AUGUST

The atomic bomb is dropped on Hiroshima. Three days later, the nuclear bomb targets Nagasaki, leading to Japan's surrender.

The atomic bomb over Hiroshima produced a 6-km column of smoke.



Employees at the test site in the desert made ready to lift the bomb into the 30-metre-high tower from where it was to launch.

around 05.10.Two bunkers were built well away from the test area, so officers and scientists could follow the trial. Their number included both project leaders – Oppenheimer for the scientists, and Groves for the military.

At 05.29.45, the bomb detonated and the area was bathed in bright white light. For a few seconds the mountains were lit by a giant dazzling fireball, as a hurricane of scorching air spread out on all sides. After 40 seconds, a shockwave was followed by an ear-splitting explosion that could be heard up to 320 kilometres away. A mushroom cloud rose 12 kilometres into the sky. The desert sand melted into a glassy, radioactive mass.

"It worked!" Oppenheimer exclaimed. A few hours later, he recalled a Hindu text: "Now I am become Death, the destroyer of worlds". Although the flash and mushroom cloud were

"Now I am become Death,

Hindu text cited by the Manhattan Project's chief scientist

Women were an important labour force at the Oak Ridge URM, which was built for the project. The city still stands today.

widely seen and heard, the military managed to keep the cause secret: a press release of only 50 words said the explosion had originated in a remote ammunition depot with no casualties.

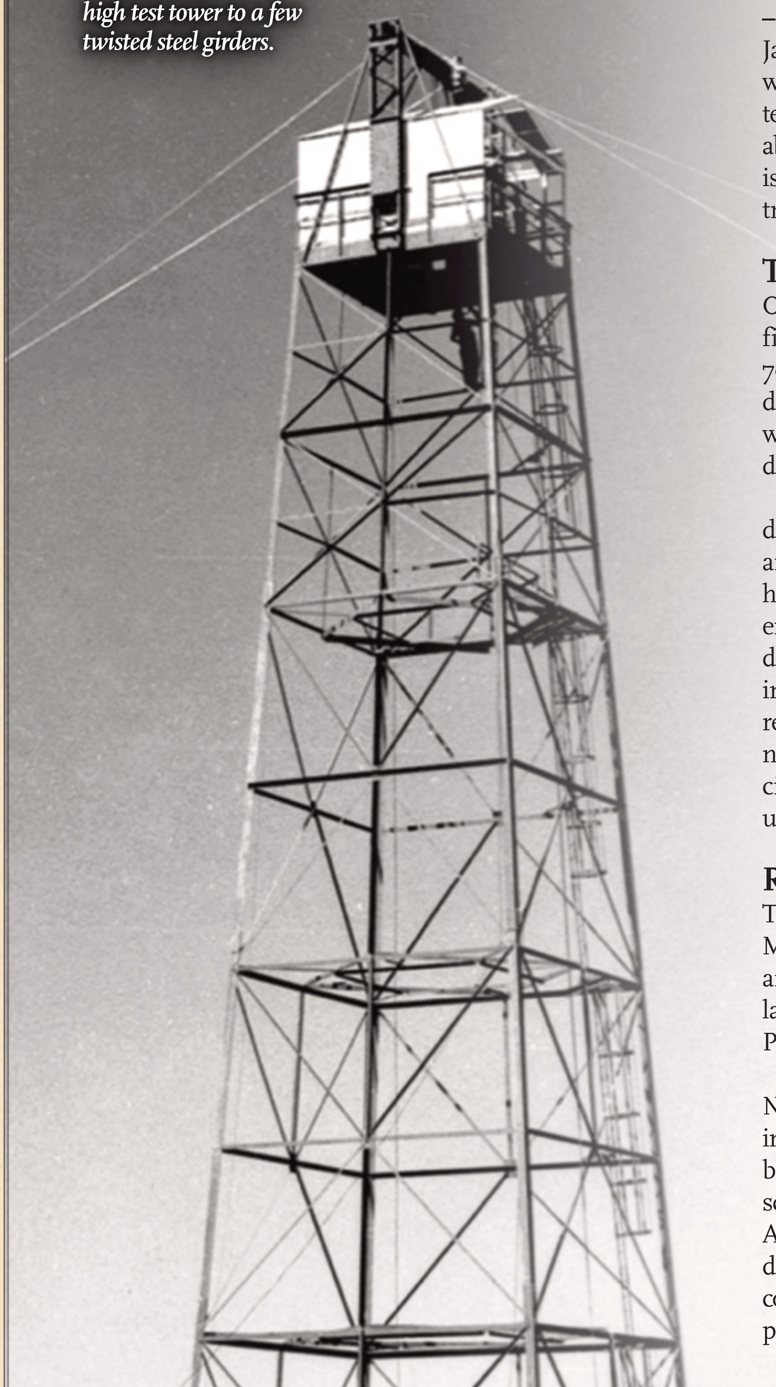
The war had ended in Europe a few months before, but in the Pacific, the fighting still raged, and the battles between the US and Japan had turned extremely bloody. The Americans had realised that the Japanese would not simply surrender. Just a few weeks earlier, the US had lost 12,500 men and the Japanese over 100,000 during the Battle of Okinawa, 1,500 kilometres south of the Japanese mainland. The Emperor's fanatical troops were clearly going to fight to the last drop of blood, and the Americans were dreading a bloody invasion of Japan.

In the months before the trial, bombers flew across the state of Utah carrying dummy versions of Fat Man

the destroyer of worlds”

Robert Oppenheimer after the nuclear test on 16th July, 1945

MAKE C.E.W. COUNT
continue to
PROTECT
PROJECT INFORMATION!



The atomic bomb reduced the 30-metre-high test tower to a few twisted steel girders.

and Little Boy to practice. A few weeks after the trial, new US President Harry S Truman ordered the first bomb be dropped – his hope was that the ultimate weapon would force the Japanese to surrender without further struggle. The bomber was already ready when the order came. On the same day as the test strike in New Mexico took place, Little Boy was bought aboard a cruiser that sailed the bomb to a US base on the Pacific island of Tinian. The other atomic bomb, Fat Man, was also transported to the island, where both bombs were readied.

THOUSANDS SUFFERED A PAINFUL DEATH

On 6th August, 1945 the B-29 bomber *Enola Gay* delivered the first payload over Hiroshima. A total of 120,000 people died, and 70,000 of Hiroshima's 76,000 buildings were left in ruins. The destruction was so complete that all communication was lost. It wasn't until the next day that the Japanese government discovered what had happened.

Japan still did not surrender, and three days later, the US dropped the Fat Man over the city of Nagasaki, resulting in another 70,000 deaths. On 15th August, Japanese listeners heard their emperor on the radio. "The enemy has begun to employ a new and most cruel bomb, the power of which to do damage is, indeed, incalculable, taking the toll of many innocent lives. Should we continue to fight, not only would it result in an ultimate collapse and obliteration of the Japanese nation, but also it would lead to the total extinction of human civilization", the emperor said when he justified the previously unthinkable – the unconditional surrender of the Rising Sun.

RESEARCH IN NUCLEAR WEAPONS CONTINUED

The historical trial and development of the Little Boy and Fat Man bombs was the culmination of the Manhattan Project and Los Alamos laboratory work. On 16th October, 1945, the lab received the Army-Navy "E" Award for its "Excellence in Production" of war materials.

After the war, Oppenheimer returned as head of the laboratory. Norris Bradbury became the new CEO, whose first goal was to industrialise the production of nuclear bombs so that they could be mass-produced and used without the help of highly educated scientists. Many of the original researchers chose to leave Los Alamos, and some became highly opposed to the continued development of nuclear weapons. However, the laboratory continued its work, which led to the development of an even more powerful weapon of mass destruction: the hydrogen bomb.

Oppenheimer and Groves inspected the blast site where the heat melted the desert sand to glass, called trinitite.

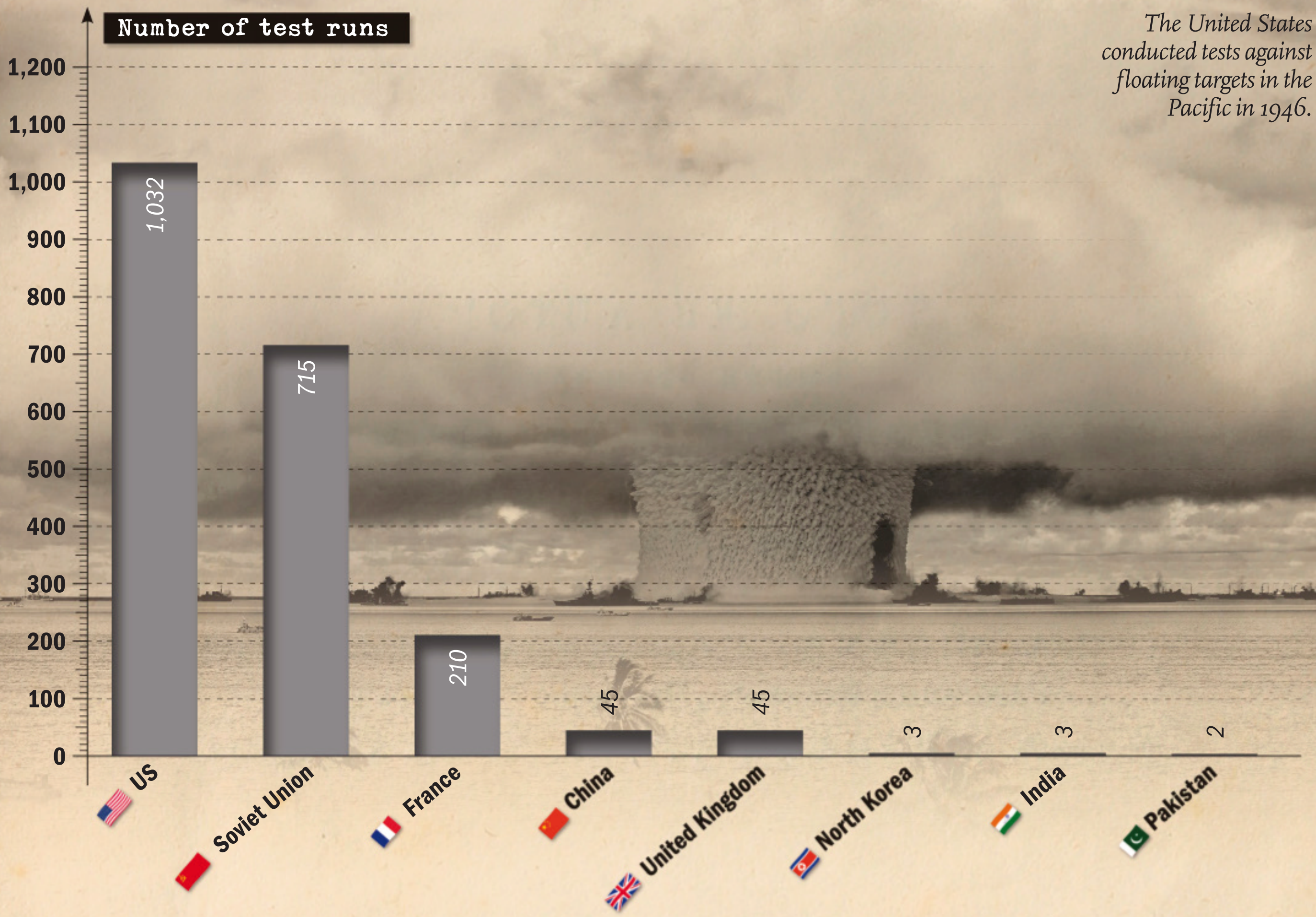
World was threatened with 78,000 bombs

The United States attempted to keep the nuclear bomb a secret. It did not succeed. The Soviet Union spied on the Americans' Manhattan Project and quickly developed its own bomb. A deadly arms race was launched.

MANHATTAN PROJECT
A
BOMB

The silver "A Bomb" pin was worn by female project staff.

Atomic bombings from 1945 to 2013

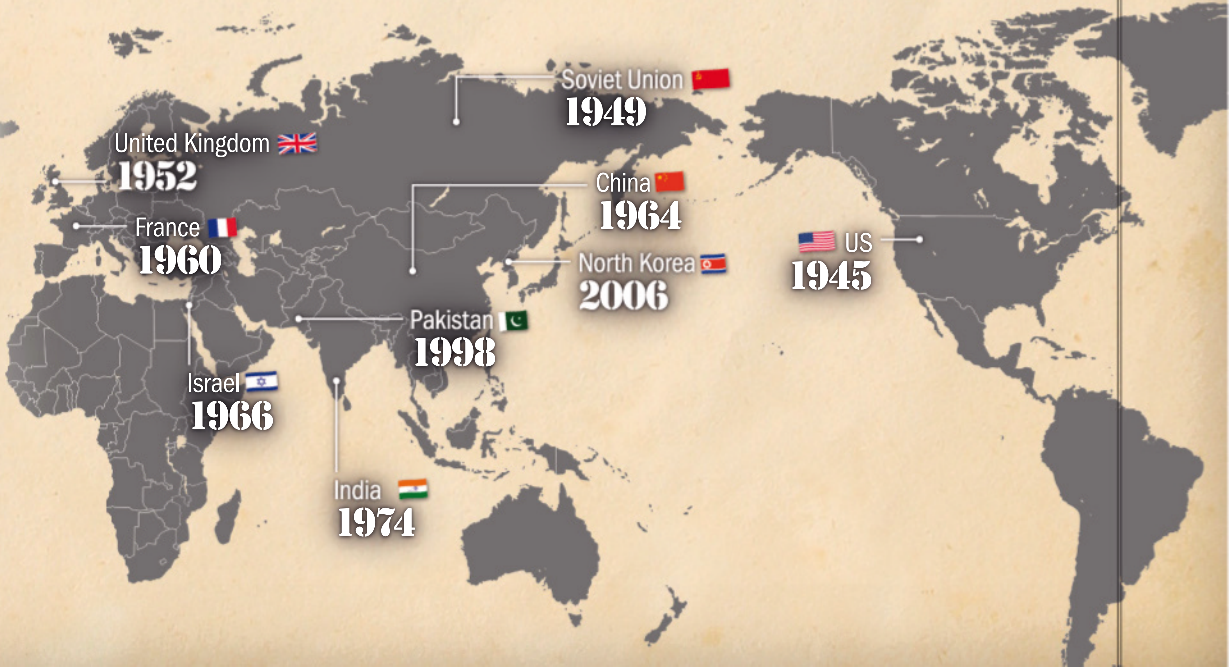


The United States conducted tests against floating targets in the Pacific in 1946.

Atomic bombs quickly spread

After the war, the US was the only country with nuclear weapons. But in 1949, the Soviet Union announced that the army had tested a bomb and was soon followed by several other countries. The Cold War was on.

At the arsenals' peak, the US carried 33,000 blast heads, and the Soviet Union 45,000. Since then, thousands of bombs have been destroyed.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DOOMSDAY DEVICE IS DEVELOPED

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